

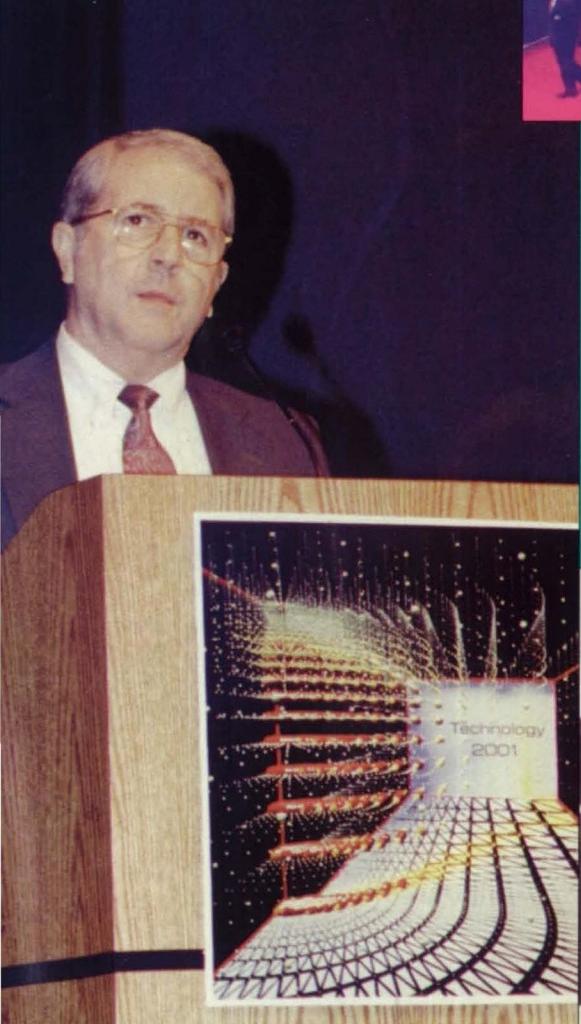
NASA TechBriefs

Official Publication of
National Aeronautics and
Space Administration
Volume 16 Number 1

Transferring Technology
to Industry and
Government
January 1992

Technology 2001:

The Road To The



FUTURE

Special Post-Show Report



THE ONLY TAPE DRIVE THAT PUTS 25GB ON A SINGLE 8MM TAPE.



Do you wish you could find a backup system with enough capacity, speed, and sophistication to backup unattended?

Could you recreate a document from scratch in the time it takes you to restore it?

FAST BACKUP, FAST RESTORE.

Introducing the CY-8500, the 8mm tape drive that gives you up to 25 GB on a single tape. And with transfer rates of up to 90 MB per minute, backup takes less time, frees resources, and makes frequent backup simple and convenient.

And that's not all. The CY-8500 offers fast file search capability. So you get the advantages of high capacity and

fast transfer rates plus the ability to locate and restore your files quickly – about 75 times faster than normal speed.

CONFIGURATION FLEXIBILITY.

The state-of-the-art liquid crystal display gives you complete drive status information. Command under execution, transfer rate,

tape remaining, and ECC are presented in a clear easy-to-read format. By offering such features as data compression – for five times the storage capacity per tape – and data encryption – giving you data access control – the CY-8500 adapts to your company's growing needs. We'll adapt to your site requirements

too, with rack mounting options and cable lengths of up to 80 feet.

PROVEN TECHNOLOGY.

Best of all, the CY-8500 offers peace of mind. 8mm helical scan technology, designed for data recording, gives you demonstrated performance and reliability. Not an adaptation of an audio recording format.

The CY-8500 is part of a complete family of tape backup products that range in capacity from the 150 MB 1/4" cartridge streamer to the 2 TB cartridge handling system. All backed up by our in-house technical support group and 12-month warranty. For more information on how you can enjoy the best value in tape backup, call today at 804/873-0900.

TRUE "PLUG-AND-PLAY" COMPATIBILITY WITH:

Alliant	DEC Unibus	PC 386/ix
Alpha Micro	Gould	PC MS-DOS
Altos	HP	PC
Apollo	IBM AS/400	Xenix/Unix
Arixlo	IBM Mainframe	Perfec
AT&T	IBM RISC/6000	Plexus
Basic-4	IBM RT	Prime
Concurrent	IBM S/38	Pyramid
Convergent	Macintosh	Sequent
DataGeneral	McDonnell	Silicon
DEC 3100	Douglas	Graphics
DEC BI-Bus	NCR	Sun
DEC HSC	Novell	Unisys
DEC Q-Bus	OS/2	Wang
DEC TU/TAB1	PS/2	and more

Circle Reader Action No. 411

CONTEMPORARY
CYBERNETICS
Group

Rock Landing Corporate Center · 11846 Rock Landing, Newport News, VA 23606 · 804/873-0900 · FAX 804/873-8836

INTRODUCING GENERIC CADD 6.0

FULL-TIME CADD AVAILABLE FOR PART-TIME WORK.

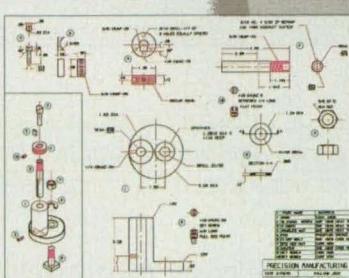
Generic CADD® 6.0 is a feature-rich computer-aided design and drafting tool for those who want high-end performance at a reasonable price. It's ideal for the busy engineer or designer who may require CADD just part of the time. Today, Generic CADD offers more power than ever.

IMPORT AUTOCAD FILES DIRECTLY

With Generic CADD 6.0 you can easily import 2D files from AutoCAD®-based designers and drafting departments. Plus, its fast DXF In/Out feature lets you work with a myriad of popular CAD, CAM, CAE and GIS software.

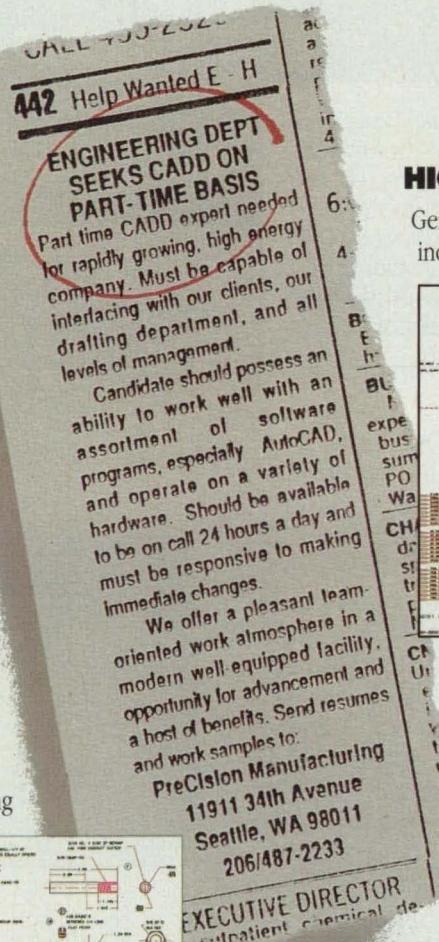
NEW FEATURES AND EASE OF USE

Generic CADD 6.0 has a new macro programming language to help you eliminate repetitive commands. Or even create new features. A multi-view option lets you split the screen into windows, each having a different zoom factor. Its bill-of-material generator builds parts lists and reports. And thanks to extensive online help and all-new tutorial, you'll be productive in just hours.



Produce professional drawings from initial concepts to finished production blueprints.

Copyright 1991 Autodesk Retail Products. All rights reserved. Generic CADD is a registered trademark of Autodesk Retail Products. AutoCAD is registered in the U.S. Patent and Trademark Office by Autodesk, Inc. WordPerfect and PageMaker are trademarks of WordPerfect Corp. and Aldus Corp., respectively. Autodesk Retail Products, 11911 North Creek Parkway South, Bothell, WA 98011, FAX 206-483-6969.

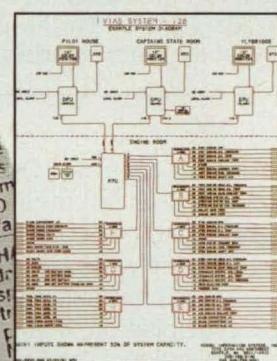


UPGRADES
AVAILABLE

HIGHLY COMPATIBLE

Generic CADD 6.0 runs on standard desktop PCs, including XT, AT, 386s and even laptops. Plus,

it works with leading word processors, desktop publishers and draw and paint programs. Such as WordPerfect, PageMaker and CorelDraw.



Easily generate process flow, system diagrams and schematics.

PRICED RIGHT— EVEN FOR PART-TIME WORK

At \$495, you can easily justify the cost of Generic CADD 6.0, even if you use it only part of the time. It's so affordable every engineer can have a copy.

For more information or the name of a Generic CADD retailer near you, call us at

1-800-228-3601, Ext. 803.



"For pure ease of use, power, and speed at a reasonable price, Generic CADD is hard to beat."

PC Magazine 12/17/91



AUTODESK

Circle Reader Action No. 420

LITTLE WONDERS!

Apis mellifera (Apidae). Common European honeybee. Managed in hives for at least 3,000 years, honeybees are the chief pollinating agent for 80% of the commercial cultivation of fruits, grains, and vegetables. Each hive consists of from 40,000 to 80,000 bees organized in a highly structured social order. Small, disciplined, adaptable, and highly productive, honeybees are one of the many wonders of nature.

Glassman Series MJ and MK regulated DC high voltage modules are little wonders in their own rights. Extremely small, lightweight, and compact, these efficient power supplies are widely used in low power CRT applications, electrophoresis measurements, ion beam experiments, particle precipitation, X-ray, imaging, and other electrostatic applications. Available in a large number of models, the 15 watt Series MJ output ranges are 0 to 3 kV through 0 to 30 kV. The 75 watt Series MK has ranges from 0 to 1 kV through 0 to 60 kV. Both the Series MJ and MK feature air insulation of critical high voltage components. This results, not only in low weight, but in easy serviceability...avoiding the problems associated with encapsulated "throw-away" modules.

Though small in size these modules are big in performance. Voltage regulation is better than 0.005% for line and load variations. Ripple is less than 0.05% (0.03%,

Series MK). Automatic crossover from constant voltage to constant current regulation protects both the supply and load from overload conditions, including arcs and short circuits. A safety interlock circuit is standard. So is remote programming and monitoring of both voltage and current, in addition to local control.



Call or write for more information on these versatile high voltage power supplies. You'll "wonder" why you ever considered anything else!

Innovations in high voltage power supply technology.

GLASSMAN HIGH VOLTAGE INC.



GLASSMAN U.S.A.

Glassman High Voltage, Inc.
P.O. Box 551
Route 22 East
Salem Industrial Park
Whitehouse Station, NJ 08889
U.S.A.
Telephone: (908) 534-9007
TWX: 710 480-2839
FAX: (908) 534-5672

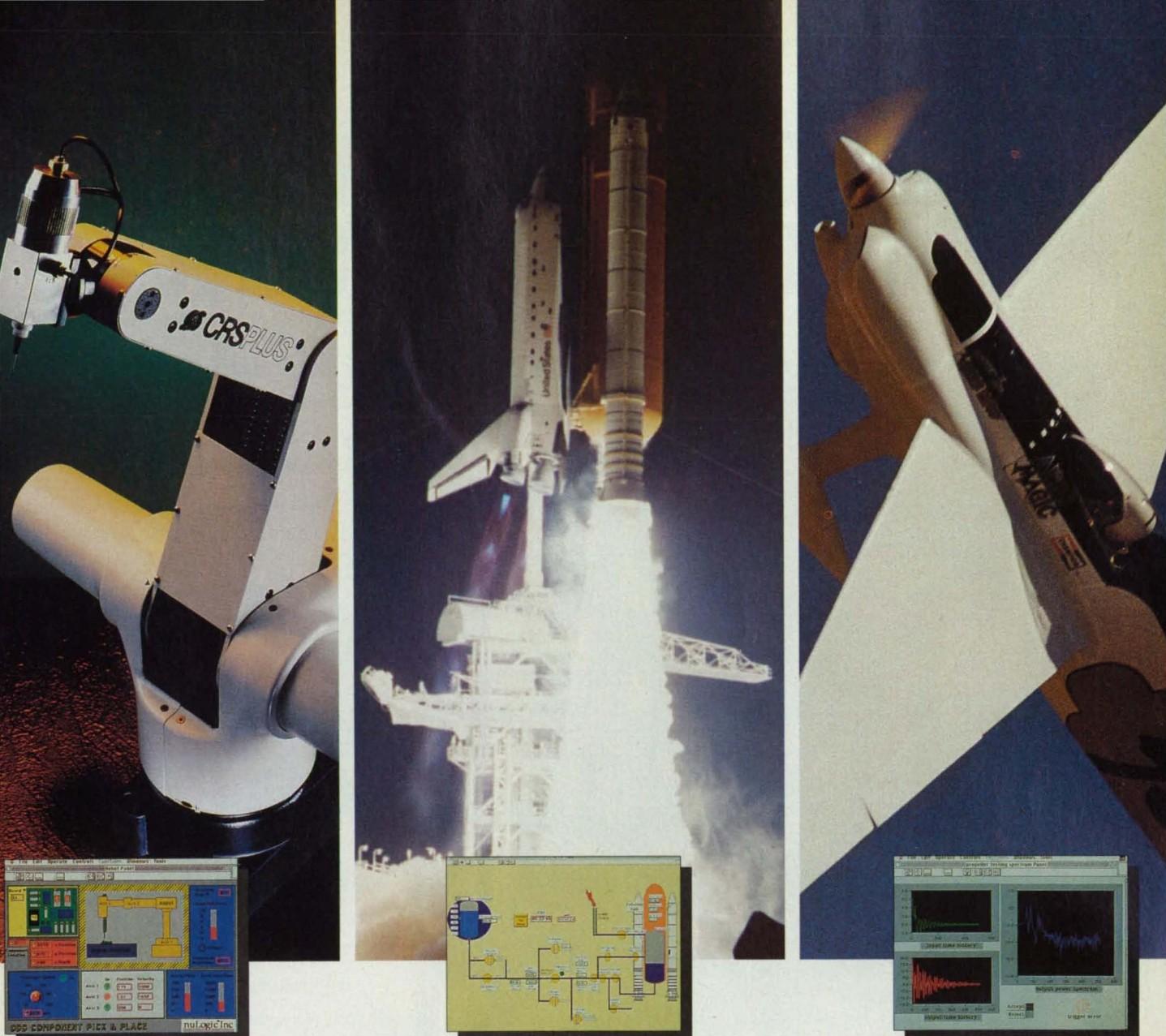
GLASSMAN EUROPE

Glassman Europe Limited
Studio 4
Intec 2
Wade Road
Basingstoke
Hampshire RG240NE
England
Telephone: (0256) 810808
FAX: (0256) 810815

GLASSMAN JAPAN

Glassman Japan High Voltage Limited
Taira Building
1-17, Taira 1-chome
Miyamae-ku, Kawasaki 216
Japan
Telephone: (044) 877-4546
FAX: (044) 877-3395

Circle Reader Action No. 358



LabVIEW® 2

Where The Only Barrier Is Your Imagination.

 By now, you are probably familiar with LabVIEW 2, the most celebrated application software for data acquisition and instrument control on the Macintosh. It recently won the *MacUser* magazine Editors' Choice award. Five years ago, LabVIEW introduced the combination of front panel interfaces and graphical programming. Today, engineers and scientists around the world are using LabVIEW 2 in a broad spectrum of applications.

Unlike other graphical packages, LabVIEW 2 does not sacrifice power and flexibility for ease of use. With LabVIEW 2, you quickly build block diagram programs and

add your own blocks to expand upon our libraries. You also create front panel user interfaces and import pictures to customize the panels. Yet LabVIEW 2 virtual instruments run as quickly as compiled C programs.

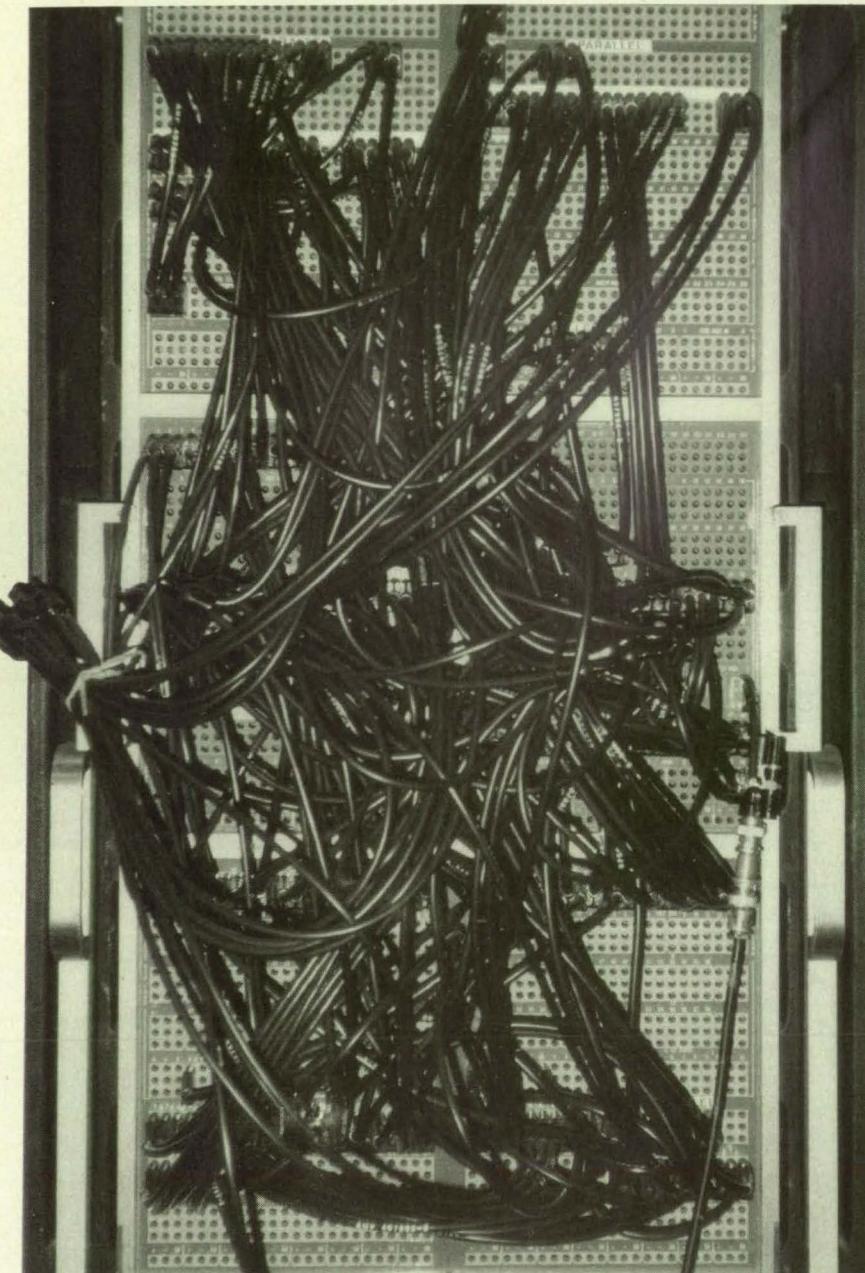
If you thought LabVIEW 2 was just for test and measurement, call us to find out what LabVIEW 2 is really about.

For a free LabVIEW 2 Demo disk call:
 (512) 794-0100 or
 (800) 433-3488
 (U.S. and Canada)



6504 Bridge Point Parkway
 Austin, TX 78730-5039

THE BEST REASON YOU EVER HAD TO CLEAN OUT THE RAT'S NEST.



Now, you can manage hundreds of signal channels with simple programming. Connect them. Change them. Verify them. A few minutes does it.

Forget the hours and expense of hand patching. Enjoy the computer

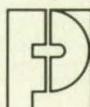


Precision Programmable Patch

control you demand for all your other instruments with the Precision Programmable Patch.

We customize the Precision Patch to your work, using standard hardware. Up to 50,000 crosspoints. Random access for your signal channels. Bank switching if you wish. Reed relays or solid state. We make the Patch fit your needs today, but expandable for tomorrow. Turnkey, of course. With all the performance you expect of Precision Filters.

Let us give you the details in terms of your signal patching. Call, write or fax. We'll help you clean out old problems.

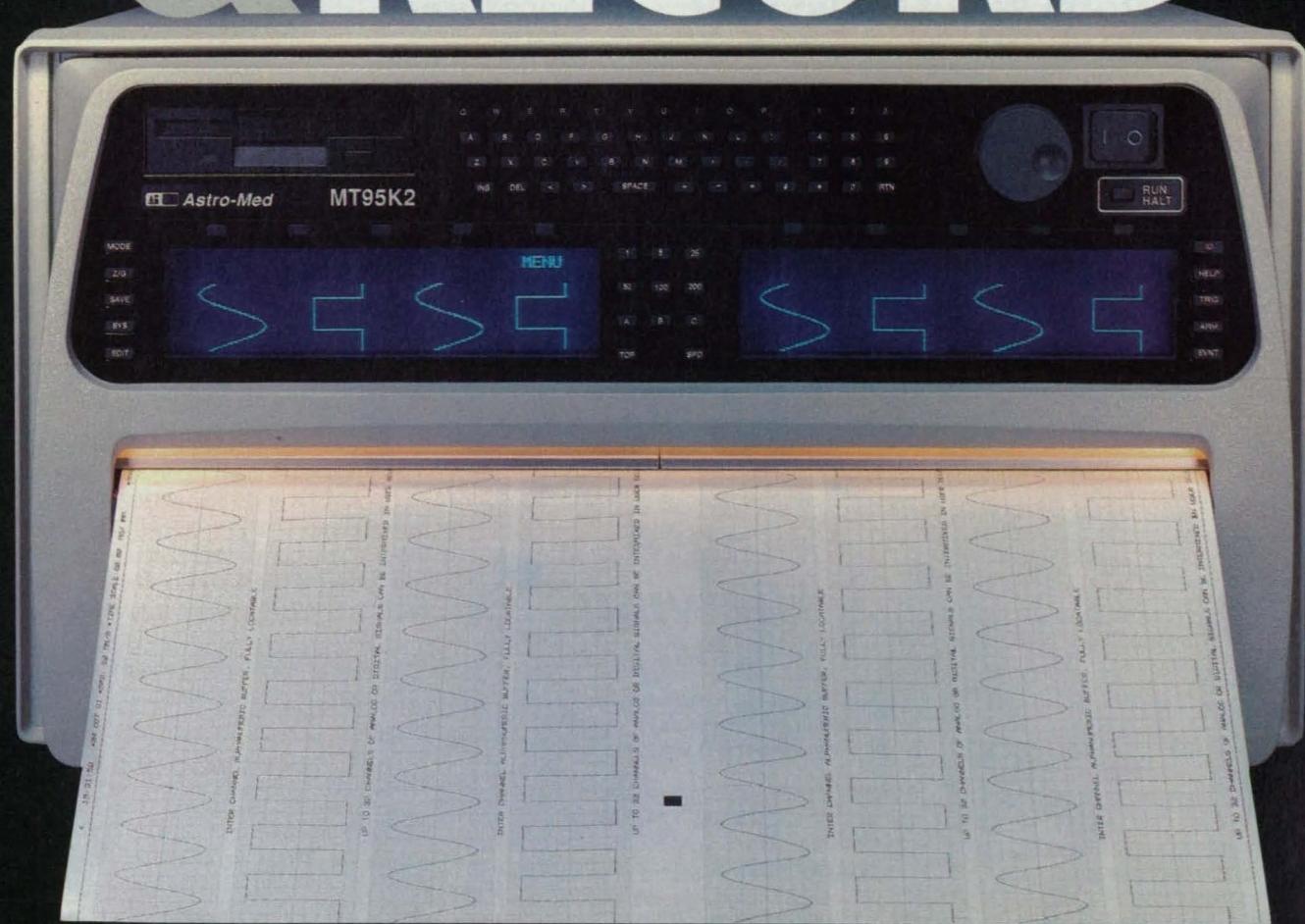


PRECISION FILTERS, INC.

240 Cherry Street, Ithaca, New York 14850
607-277-3550 Fax: 607-277-4466

Circle Reader Action No. 306

THE ALL NEW ASTRO-MED MONITOR & RECORD



- No Delay...see full traces on monitor while recording!
- Personal Chart Setups with on-board floppy drive
- Data Capture...up to 32 megabytes in RAM;
120 megabyte internal hard drive; stream to external
drive via SCSI
- 8 to 32 Waveform Channels...plus 64 events; DC to
20 kHz; chart speeds to 500 mm/sec
- Laser Printer Chart Resolution...300 dpi; clear,
crisp traces

Put simply, the MT95K2 is another major Astro-Med innovation in "chart recording": you can preview your

data, record it, store it, play it back, send it to disk for analysis, record it again, and more! Whether you need a basic 8 channel recorder or a sophisticated 32 channel recording system, the MT95K2 is the perfect platform for you today.

Call, Fax, or write for details!



Astro-Med, Inc.

Astro-Med Industrial Park, West Warwick, Rhode Island 02893
Phone: (401) 828-4000 • Toll Free (800) 343-4039
Fax (401) 822-2430 • Telex 710-382-6409

SPECIAL FEATURES

Editorial Notebook	10
1991 Subject Index	81
Mission Accomplished	116

TECHNICAL SECTION

	New Product Ideas	12
	NASA TU Services	14
	Electronic Components and Circuits	16
	Electronic Systems	24
	Physical Sciences	32
	Materials	46
	Computer Programs	52
	Mechanics	58
	Machinery	66
	Fabrication Technology	68
	Mathematics and Information Sciences	74
	Life Sciences	79
	Subject Index	113



Illustration courtesy Ames Research Center

A proposed oblique-flying-wing aircraft would transport passengers and cargo at twice the speed of sound, yet cost the same as current subsonic planes. The tech brief on page 66 explains how the craft would work.

DEPARTMENTS

New on the Market	110
New Literature	111
Advertisers Index	115

On The Cover: NASA administrator Richard H. Truly (bottom left photo) gave the keynote address at Technology 2001, the second national technology transfer conference, which featured over 200 exhibitors and 120 technical presentations, and which attracted nearly 4000 attendees to the San Jose convention center. Our show report, including excerpts from Mr. Truly's remarks, begins on page 10.
(Photos courtesy Ames Research Center)

This photo of the ice-covered Kerguelen Island in the South Indian Ocean was captured by the space shuttle's electronic camera from an altitude of 325 miles. The image was processed and color-enhanced using a new software package developed with NASA's help. See Mission Accomplished, page 116.

Photo courtesy Electronic Imagery Inc.



This document was prepared under the sponsorship of the National Aeronautics and Space Administration. Neither Associated Business Publications Co., Ltd. nor anyone acting on behalf of Associated Business Publications Co., Ltd. nor the United States Government nor any person acting on behalf of the United States Government assumes any liability resulting from the use of the information contained in this document, or warrants that such use will be free from privately owned rights. The U.S. Government does not endorse any commercial product, process, or activity identified in this publication.

Permissions: Authorization to photocopy items for internal or personal use, or the internal or personal use of specific clients, is granted by Associated Business Publications, provided that the flat fee of \$3.00 per copy is paid directly to the Copyright Clearance Center (21 Congress St., Salem, MA 01970). For those organizations that have been granted a photocopy license by CCC, a separate system of payment has been arranged. The fee code for users of the Transactional Reporting Service is: ISSN 0145-319X192 \$3.00+ .00

NASA Tech Briefs, ISSN 0145-319X, USPS 750-070, copyright © 1992 in U.S., is published monthly by Associated Business Publications Co., Ltd., 41 E. 42nd St., New York, NY 10017-5391. The copyrighted information does not include the (U. S. rights to) individual tech briefs which are supplied by NASA. Editorial, sales, production and circulation offices at 41 East 42nd Street, New York, NY 10017-5391. Subscription for non-qualified subscribers in the U.S., Panama Canal Zone, and Puerto Rico, \$75.00 for 1 year; \$125.00 for 2 years; \$200.00 for 3 years. Single copies \$10.00. Foreign subscriptions one-year U.S. Funds \$150.00. Remit by check, draft, postal, express orders or VISA, MasterCard, and American Express. Other remittances at sender's risk. Address all communications for subscriptions or circulation to NASA Tech Briefs, 41 East 42nd Street, New York, NY 10017-5391. Second-class postage paid at New York, NY and additional mailing offices.

POSTMASTER: please send address changes to NASA Tech Briefs, 41 E. 42nd Street, Suite 921, New York, NY 10017-5391.

Take a look at what the DS345 Synthesized Function Generator offers for only \$1895.

30 MHz direct digitally synthesized source
1 μ Hz resolution

12 bit, 40 Msample/sec arbitrary waveform generation

Low phase noise and distortion

Fast phase continuous frequency and phase switching

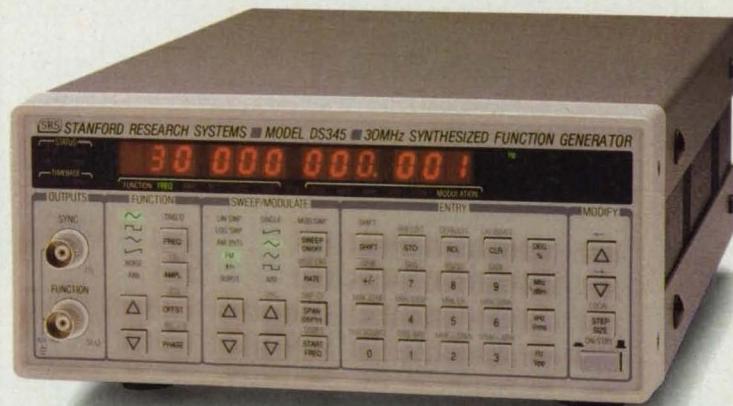
Sine, square, ramp, and triangle waveforms

Frequency, amplitude, and phase modulation

Sweep and burst modes

Available GPIB and RS232 interfaces

Now take a look at your function generator.



The DS345 from SRS.
At \$1895, it's the only function generator you need.



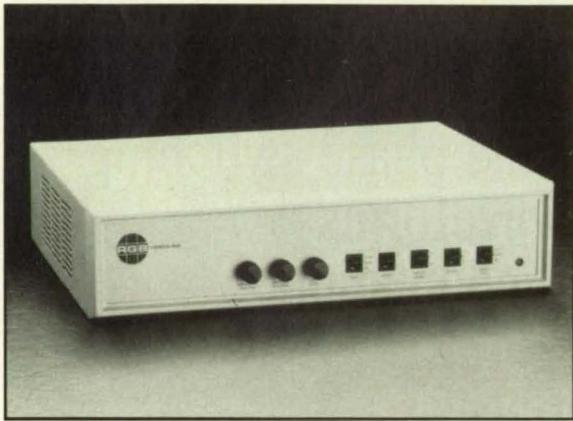
STANFORD RESEARCH SYSTEMS

1290 D Reamwood Avenue, Sunnyvale, CA 94089 TEL (408)744-9040 FAX 4087449049 TLX 706891 SRS UD

Circle Reader Action No. 445

New Model

Convert Computer Graphics to Television



RGB/Videolink® Model 1450AX with Auto-sync

The versatile full range scan converter for video taping, video projection and video teleconferencing

- Adjustment free auto-locking to all workstations, PCs and Mac IIs
- Horizontal scan range 21 to 80 kHz
- Full broadcast quality encoder and sync generator
- Flicker free output
- Genlock
- Linear keyer for overlaying live video with computer graphics
- Zoom EGA to fill video screen
- Full 24 bit color processing
- Wide range of outputs; Composite (NTSC or PAL), RGB, S-Video, Betacam / MII
- Manufactured in the USA
- Other models available from \$10,995



SPECTRUM

950 Marina Village Parkway Alameda, CA 94501
Tel: (510) 848-0180 Fax: (510) 848-0971

NASA Tech Briefs

Official Publication of
National Aeronautics and
Space Administration

ABP  BPA 

NASA Tech Briefs:

Published by	Associated Business Publications
Editor-in-Chief/Publisher	Bill Schnirring
Associate Publisher	Frank Nothaft
Editor	Joseph T. Bramberger
Managing Editor	R.J. Laer
Associate Editor	Sarah L. Gall
Assistant Editor	Justina Cardillo
Assistant Editor	Patrick Corbett
Technical Advisor	Dr. Robert E. Waterman
Production Manager	Rita Nothaft
Traffic Manager	James E. Cobb
Art Director	Pierre Granier
Marketing Director	Wayne Pierce
Assistant Circulation Manager	Nipa Joshi
Advertising Coordinator	Daniel Murphy
Telecommunications Specialist	Evelyn Mars
Reader Service Manager	Sylvia Valentin

Briefs & Supporting Literature:

Provided to National Aeronautics and Space Administration by	
International Computers & Telecommunications, Inc.,	
NY, NY with assistance from Logical Technical Services, NY, NY	
Technical/Managing Editor	Ted Selinsky
Art Director	Luis Martinez
Administrator	Elizabeth Texeira
Chief Copy Editor	Lorne Bullen
Staff Writers/Editors	Dr. James Boyd, Dr. Larry Grunberger, Dr. Theron Cole, Jordan Randjelovich, George Watson, Oden Browne
Graphics	Zinaida Gimpeleva, Vernald Gillman, Pamela Bayham, Charles Sammartano
Editorial & Production	Bill Little, Yvonne Valdes, Susan Kyu Oh, Frank Ponce

NASA:

NASA Tech Briefs are provided by the National Aeronautics and Space Administration, Technology Utilization Division, Washington, DC:	
Administrator	Richard H. Truly
Assistant Administrator for Commercial Programs	James T. Rose
Deputy Assistant Administrator(Programs)	Frank E. Penaranda
Deputy Director TU Division(Publications Manager)	Leonard A. Ault
Manager, Technology Utilization Office, NASA Center	
For AeroSpace Information	Walter M. Heiland

Associated Business Publications

41 East 42nd Street, Suite 921, New York, NY 10017-5391
(212) 490-3999 FAX (212) 986-7864

President	Bill Schnirring
Executive Vice President	Frank Nothaft
Vice President	Domenic A. Mucchetti
Operations Manager	Rita Nothaft
Controller	Felecia Lahey
Systems Analyst	Patrick Wolfert

Advertising:

New York Office:(212) 490-3999 FAX (212) 986-7864

Director of Advertising Sales	Domenic A. Mucchetti
Account Executive (NY,NJ,OH,MI)	at (201) 366-2751

Account Executive (VA,DC,MD,DE,WV)	John D. Floyd, CBC at (215) 399-3265
Account Executive	Debby Crane at (201) 967-9838

Regional Manager (Midwest)	Paul Lesher, CBC at (312) 296-2040
Account Executive (Northwest)	Bill Hague at (206) 858-7575

Regional Sales Manager (South)	Douglas Shaller at (212) 490-3999
Account Executives (Eastern MA,NH,ME,RI)	Paul Gillespie at (508) 429-8907; Bill Doucette at (508) 429-9861

Account Executives (Western MA,CT,VT)	George Watts at (413) 253-9881
Account Executives (Calif.,AZ,NV,NM)	for Area Codes 602/702/505 Paul Sanacore for Area Codes 213/810/619/714 Tom Stillman, Robert D'Alexander for Area Codes 408/415/916/209/707/801 Ron Hall at (310) 372-2744

NTBM-Research Center
Account Supervisor

Lourdes Del Valle

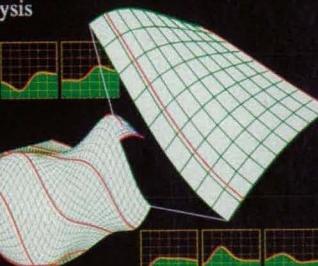
GRAFTOOL™

"is the best choice..."
and "...delivers on all accounts."

Reprinted with permission from PC Magazine, March 26, 1991, Copyright ©1989 Ziff Communications Co. and PC Magazine, November 13, 1990 ©Ziff Communications Co.

March 26, 1991
Graftool, Version 3.3

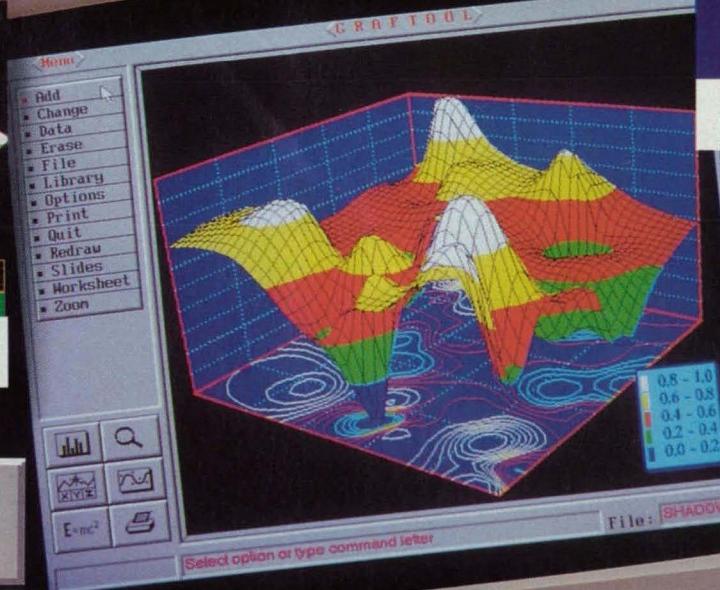
Surface Cross-Section
Analysis



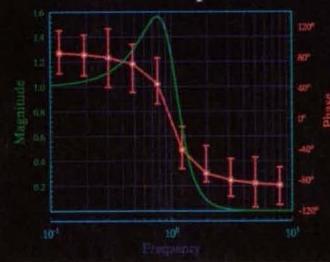
Create contours, surfaces, and cross-sections from random X, Y, Z points.



EW push-button "mouse-menus" allow easy access to frequently used features.



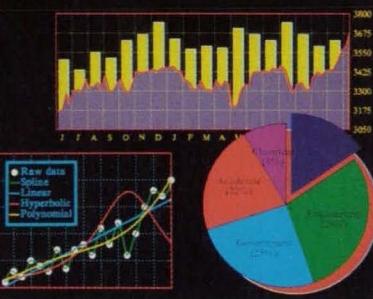
Filter Response



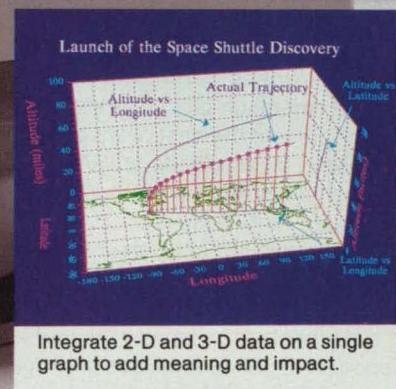
Automate customized graph creation with pre-recorded macro & batch files.



Easily create complex curves & surfaces with the graphical Formula-Solver™.



Choose from 26 graph types for business, technical, & scientific data.



Integrate 2-D and 3-D data on a single graph to add meaning and impact.

Presentation graphics and analysis for scientific users.

Your technical data requires more muscle and sophistication than basic business graphics and plotting packages can provide. It's simply a matter of using the right tool for the job. In addition to publication-quality graphics, you need powerful analysis tools and capabilities such as Graftool's ■ Intelligent Data Cursor™ to read out data points on curves & surfaces ■ Linear & non-linear curve-fitting ■ Unlimited zoom & rotation ■ Multiple axes in linear, log, or probability scales ■ Advanced data handling, allowing over 268,000,000 data points ■ Powerful scientific spreadsheet which can directly read your Lotus or ASCII files

- Unrestricted placement of graphs & text
- Direct compatibility with Microsoft Word & WordPerfect.

With Graftool, all this power and flexibility purr quietly under the hood, while pop-up menus and push-buttons bring an ease of use previously unheard of in scientific software. Just "point & process" with increased productivity and greater understanding.

GRAFTOOL — the right tool for your technical solutions.

GRAFTOOL \$495.

- Interactive demo available
- Academic discounts.



3-D VISIONS

Call Toll Free for Details

1-800-729-4723

2780 Skypark Drive, Torrance, CA 90505

Circle Reader Action No. 669



Editorial Notebook

Technology 2001: Bigger, Better, And Just The Beginning

Well, it's supposed to be easier the second time. I don't know about that. But it certainly was bigger, better, and even more fun. Perhaps it would have been easier too if we hadn't had twice the exhibit space and 50 percent more attendees than at last year's inaugural event, Technology 2000.

For the record, there were 220 exhibitors occupying 50,000 square feet of exhibit space (4,645 square meters for the metrically-minded) in the San Jose convention center for Technology 2001, the second national technology transfer conference and exposition. Chief scientists, research directors, project leaders, corporate executives...nearly 4000 of the top tier of technology managers in industry and government attended this year's conference, which was expanded from two to three days.

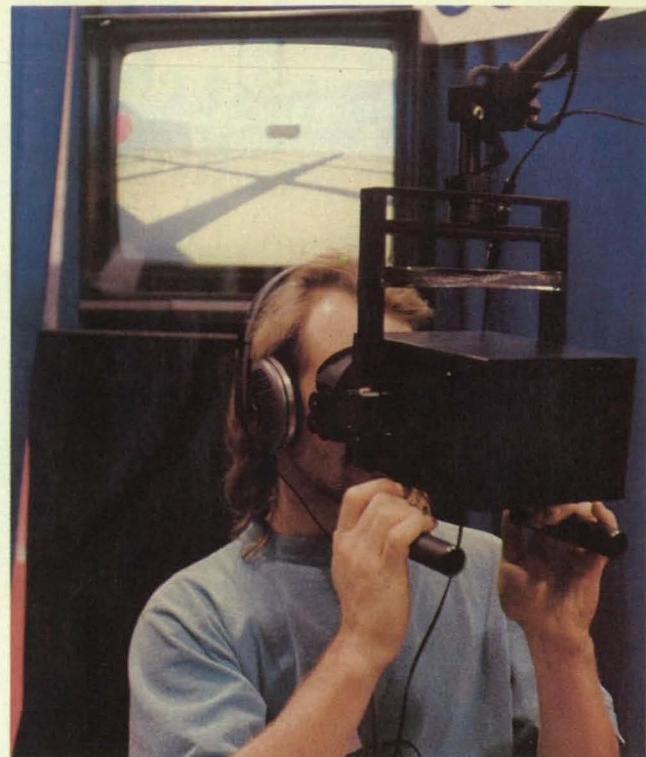
Attendees included over 100 members of the print and electronic media. Virtually every major engineering trade publication was represented, as were consumer magazines such as *Byte* and *Popular Science*. Technology 2001 was covered on ABC, CBS, and a number of cable channels, including CNN. The latter devoted an entire segment of *Future Watch* to the show.

Dr. D. Allan Bromley, science advisor to President Bush, urged NASA to expand Technology 2001 to include its sister agencies and other high-tech organizations, so that the show would truly represent the best of US technology available for industry's use. The result, as NASA administrator Richard Truly commented in his keynote speech (see excerpts on following page), was "impressive." Ten federal agencies joined NASA in exhibiting and presenting papers on their latest inventions available for transfer. Over the course of three days, 120 papers were presented in such diverse, yet interrelated, fields as biotechnology, computing, manufacturing, and materials science. In all, 50 federal labs participated, including 15 Department of Energy R&D facilities and all branches of the Department of Defense.

This, however, was only the beginning. For Technology 2002, to be held December 1-3, 1992 in the Baltimore, MD convention center, we plan to further expand the scope of the exhibits and technical presentations. Look for a "call for papers" in the next issue of *NASA Tech Briefs*, and other exciting details in subsequent editions. If you attended Technology 2001 and have suggestions for this year's event, we would love to hear from you. Call me or Joe Pramberger at (800) 944-NASA.

See you in Baltimore.

For information on obtaining the complete proceedings of Technology 2001, see page 93.



Above: Visitors to the Ames Research Center exhibit were transported to a "virtual" world via a computer system that generates 3D images and sounds.

Left: Pacific Northwest Laboratory, a Department of Energy R&D facility, showcased an array of environmental technologies, including an electro-optic sensor that precisely measures water and liquid contaminant levels in soil.

Bottom: NASA's exhibits included a "theater island" with a 20-foot video wall and models of the space shuttle and National Aero-Space Plane.





Above: Robert M. White, under secretary of the Department of Commerce for technology, addressed audience of 500 at the 1991 Technology Transfer Awards Dinner, held in conjunction with Technology 2001.

Right: Technology 2001 attracted TV, newspaper, and magazine reporters from across the nation.



Truly: Spinoffs Will Spur Economy



Richard H. Truly

Following are excerpts from the Technology 2001 keynote address by NASA administrator Richard H. Truly.

Given the erosion we have seen in America's competitive position, I cannot think of a subject more important to our economy than that being addressed (at Technology 2001): cutting-edge technology.

How valuable to the economy is the transfer of government-developed technology? Is there really a big payoff? The answer is...absolutely.

NASA's experience is a prime example. Our programs have spurred a revolution in new products and processes—more than 30,000 of them—to improve the quality of living and boost American competitiveness in the world marketplace. Just in the past decade, the bottom line on quantifiable benefits has been exceptional. Combined sales and savings amounted to almost \$22 billion. Some 259 spinoff applications led to the creation or retention of 352,000 jobs over that decade. In 67 instances, the products or processes—and, in some cases, entire companies—would not have come into existence without NASA technology. These cases alone resulted in sales or savings totaling more than \$5 billion.

The challenge ahead is for our space program to continue to drive spinoff technologies, and for American industry to more effectively bring derived products to a profitable marketplace.

Space technology spinoffs will receive a powerful new boost from space station Freedom. Freedom will allow us to pursue materials and life sciences research on an uninterrupted basis in a totally new environment: the world of microgravity.

On Earth, industry alters natural materials like iron ore by employing the physical phenomena you find here—heat, electricity, pressure, gravity, vacuum, magnetism, and so on. The outcome is a tremendous range of alloys, crystals, ceramics, electronic materials, pharmaceuticals, and more.

The new environment of microgravity and ultra-vacuum gives us additional control. Now we can eliminate the disturb-

ing effects of convection, buoyance, and hydrostatic pressure. The result: great improvements in existing materials and creation of new materials.

We are talking about materials that will be stronger, lighter, and more heat-resistant than anything known on Earth. We are talking about super-quality semiconductors, resulting in super-fast computers. We are talking about pharmaceuticals, perhaps even to attack diabetes, cancer, and AIDS.

Once we get continuous access to microgravity, access the station provides, we can engage in continuous experimentation to build up sound statistical bases. This will enable industry to establish the processes and controls required for quality commercial production, including production in space.

Another key area for technology development and transfer is life sciences. Life sciences research on the space shuttle and space station Freedom will have a big payoff on Earth. We will use our new knowledge to combat cardiovascular diseases, hypertension, and osteoporosis. It will give us new insights into aging, anemia, diabetes, muscle atrophy, and the basic immune function. Biomaterial will be developed to use for artificial skin, tendons, blood vessels, and the cornea.

NASA's aeronautics research has been providing tremendous technologies to industry for years. Today, we do a great deal of aeronautics research focused on the traditional goals of better performance, greater economy, and improved safety. One of our largest efforts is the resumption of research on a high-speed civil transport and the development of the National Aero-Space Plane, which is highlighted in an impressive exhibit at this conference. A substantial market is developing for a fleet of supersonic transports to serve the Pacific rim and transatlantic routes. Our research will help keep America at the forefront of this rapidly expanding opportunity.

Virtually all of this is setting the stage for the next great adventure in space: sustained human exploration of the solar system. Today, we possess the basic technical skills required to begin the expansion of the human race off the mother planet; to take another step in the evolution of the human race.

When we can muster the financial resources, human beings can return to the moon—this time to stay. Enormous opportunities await us there. It is rich in mineral resources. Telescopes on its dark side would be far more powerful than any on Earth or in space. And it is the perfect nearby classroom and laboratory to prepare for Mars.

Mars gives us the opportunity to explore for the first time in human history another planet, much like our own in many respects, but radically different in others.

(continued on page 114)

New Product Ideas

New Product Ideas are just a few of the many innovations described in this issue of *NASA Tech Briefs* and having promising commercial applications. Each is discussed further on the referenced page in the

appropriate section in this issue. If you are interested in developing a product from these or other NASA innovations, you can receive further technical information by requesting the TSP referenced

at the end of the full-length article or by writing the Technology Utilization Office of the sponsoring NASA center (see page 14). NASA's patent-licensing program to encourage commercial development is described on page 14.

Tissue-Simulating Gel for Medical Research

A new gel features thermal stability, which should make it useful for studying hypothermia as a treatment for cancer. The gel retains its shape without a supporting shell for simpler ultrasonic analysis. Liquids can be injected into it by hypodermic needle as into real tissue and can be viewed from outside.

(See page 80)

Stall-Departure-Resistance Enhancer

This enhancer improves the stall departure resistance of aircraft operating at or near angle of attack of a wing. The enhancer imposes a lesser drag penalty than do conventional vortex generators. It increases lift by as much as 30 percent.

(See page 61)

Improved Warm-Working Process for an Iron-Base Alloy

This process produces a predominantly unrecrystallized grain structure in forgings of an iron-base alloy. Billets forged this way have demonstrated improvements in yield and ultimate strengths and decreased elongation and reduction of area at break.

(See page 69)

Thin-Membrane Sensor With Biochemical Switch

A modular sensor electrochemically detects a chemical or biological agent. Possible applications include detection of bacterial toxins in food, poison gases in the air, and pesticides or other pollutants in the environment.

(See page 79)

Open-Pinned-Phase Charge-Coupled Device

These devices combine best attributes of multiphase and virtual-phase technologies. A relatively high quantum efficiency can be achieved to cover an expanded range of 1 to 11,000 Å. Other attributes include bidirectional clocking and ultralow dark-current generation.

(See page 16)

Acoustic Device Would Measure Density of Gas

A proposed sensor would measure the density of a flowing gas or mixture of gases via the amplitude of a low-frequency acoustic signal. The sensor could be configured in a variety of ways for monitoring industrial processes.

(See page 34)

Save hours over your current curve fitting methods with the new TableCurve v3.0! TableCurve will fit and rank 3320 linear and non-linear equations to your dataset in one highly automated processing step! Step through ranked equations, view residuals, statistics and graphs – and output data and graphs easily in a variety of formats! Features include:

▲ 3,320 Linear and Non-linear equations

Includes polynomial, rational, peak (Gaussian, Lorentzian, etc), transition, waveform and many others.

Select only the equation groupings of interest or let Table Curve fit all equations to your data!

▲ User defined

equations Define your own equations –

TableCurve fits and ranks them along with the extensive list of built-in equations.

▲ Extensive fitting and ranking choices Choose curve fitting algorithm (Singular Value Decomposition, Gauss-Jordan, LU Decomposition), best fit ranking criteria (DOF adj. r^2 , Fit Std Error, F-statistic and Std r^2), smoothing functions (polynomial interpolation, FFT and Lowess) and more!

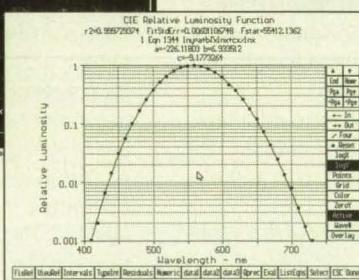
▲ High speed processing Automatically fit and rank all 3,304 linear equations to a 50 point dataset in 46 seconds (using 80386SX, 16MHz with math coprocessor). Iteratively fit non-linear equations are also processed in amazing speed!

▲ Unique graphical review process Graphically

Total Equations=2784	Last Reviewed: Rank=1 Equation#1344	12:57 PM
1 55412_13623	1344	36 ln(a+b*x*c*x*x)
2 55316_58020	1248	25 ln(a+b*x*c*x*x)
3 55311_49156	1218	25 ln(a+b*x*c*x*x)
4 54839_88960	1218	15 ln(a+b*x*c*x*x)
5 54838_88969	1221	15 ln(a+b*x*c*x*x)
6 54838_717658	1237	35 ln(a+b*x*c*x*x)
7 54464_89351	1228	35 ln(a+b*x*c*x*x)
8 54464_89352	1253	24 ln(a+b*x*c*x*x)
9 53915_372344	1254	24 ln(a+b*x*c*x*x)
10 53679_779134	1294	28 ln(a+b*x*c*x*x)
11 53495_373827	1366	28 ln(a+b*x*c*x*x)
12 53426_70724	1258	18 ln(a+b*x*c*x*x)
13 53426_70725	1218	18 ln(a+b*x*c*x*x)
14 52464_164657	1293	34 ln(a+b*x*c*x*x)
15 52290_8518	1239	33 ln(a+b*x*c*x*x)
16 51715_339852	1258	33 ln(a+b*x*c*x*x)
17 51715_339853	1258	33 ln(a+b*x*c*x*x)
18 50163_901827	1295	34 ln(a+b*x*c*x*x)
19 49626_631778	1326	34 ln(a+b*x*c*x*x)

Select Equation or Re-Sort Alt-R,D,S,F List 25

NEW **TableCurve™ 3.0**
Automated Curve Fitting Software
One Step Fits 3,320 Linear and Non-linear Equations to Your Data – Automatically!



view the fit of each equation to your data by pressing a key. Also obtain a full numerical review of confidence/ prediction limits, residuals and other statistics.

▲ Flexible data input/output Import a huge dataset from ASCII, Quattro Pro®, Lotus®, dBase™, and other formats. Customize selected graphs and output to a variety of devices including LaserJet®, Postscript™ printers, or export directly

to SigmaPlot®, Lotus and more!

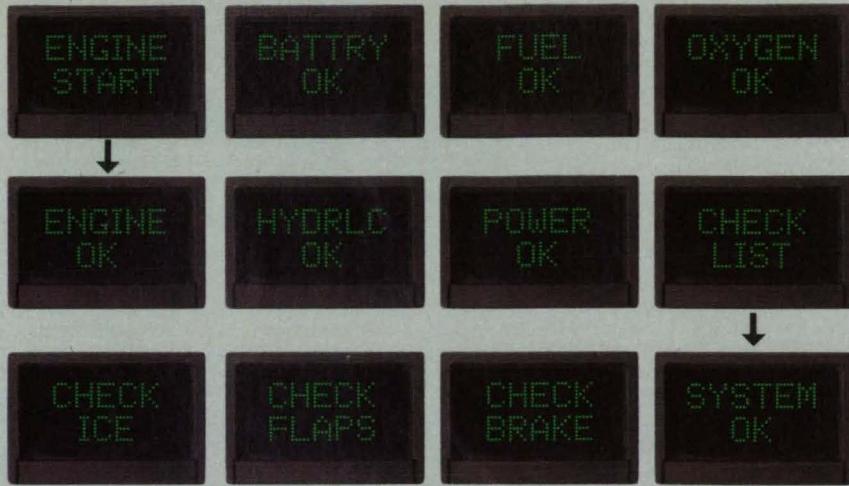
▲ Export programming code for any selected equation Automatic code generation for programming in C, Pascal, FORTRAN, and several BASIC languages.

▲ Outstanding ease of use With a superb user interface, full mouse support and extensive online help, TableCurve brings powerful linear and non-linear curve fitting to your PC in an easy-to-use, intuitive format.

TableCurve is reasonably priced, backed by a full money-back guarantee and one of the strongest technical support staffs in the industry. Call Jandel today for more information on TableCurve and other scientific software: 1-800-874-1888 (inside U.S.) or 1-415-453-6700.

Jandel
SCIENTIFIC
"Microcomputer Tools for the Scientist"

Our European office is:
Schimmlerbuschstrasse 25
D-4006 Erkrath 2 • FRG
02104/36098
02104/36099



AN APPLICATIONS EXAMPLE.

While the following example is for aircraft, it could apply to any air, land, sea or space system.

SEQUENCE ONE: The four-pushbutton display reads "ENGINE START," "BATTERY OK," "FUEL OK," "OXYGEN OK." The operator selects "ENGINE START."

SEQUENCE TWO: The four-pushbutton display now changes to read "ENGINE OK," "HYDRLC OK," "POWER OK," "CHECK LIST." The operator selects "CHECK LIST."

SEQUENCE THREE: The four-pushbutton display now reads "CHECK ICE," "CHECK FLAPS," "CHECK BRAKE," "SYSTEM OK." In this manner, the designer can program in as many sequences as required.

Design flexibility: The programmable display system.

Vivisun Series 2000, now the leading programmable display pushbutton system, interfaces the operator with the host computer. The user-friendly LED dot-matrix displays can display any graphics or alpha-numerics and are available in green, red or amber. They can efficiently guide the operator through any complex sequence with no errors and no wasted time.

They also simplify operator training as well as control panel design. One Vivisun Series 2000

programmable display system can do the work of 50 or more dedicated switches. In short, Vivisun Series 2000 gives the design engineer more control over the design.

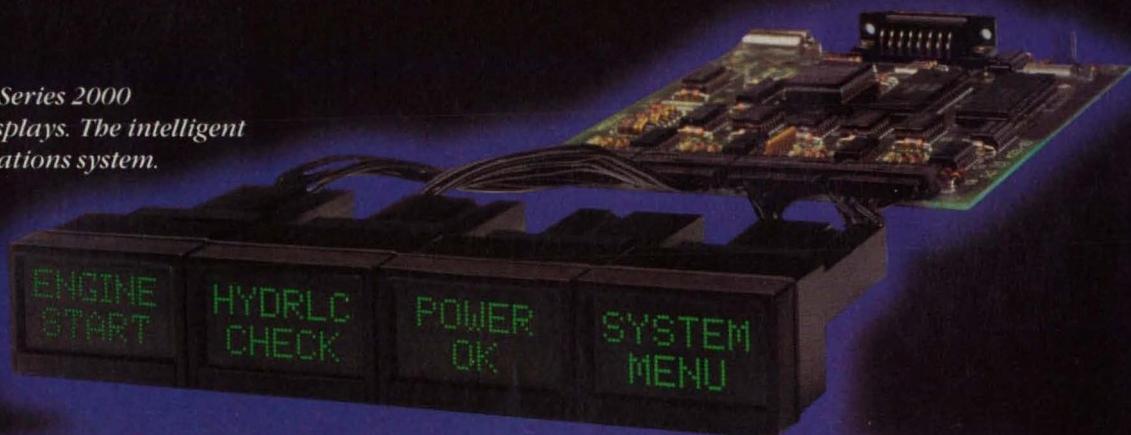
Contact us today.



AEROSPACE OPTICS INC.

3201 Sandy Lane, Fort Worth, Texas 76112
(817) 451-1141 • Telex 75-8461 • Fax (817) 654-3405

*Vivisun Series 2000
programmable displays. The intelligent
communications system.*



SERIES

VIVISUN 2000™



HOW YOU CAN BENEFIT FROM NASA'S TECHNOLOGY UTILIZATION SERVICES

If you're a regular reader of TECH BRIEFS, then you're already making use of one of the low-and-no-cost services provided by NASA's Technology Utilization (TU) Network. But a TECH BRIEFS subscription represents only a fraction of the technical information and applications/engineering services offered by the TU Network as a whole. In fact, when all of the components of NASA's Technology Utilization Network are considered, TECH BRIEFS represents the proverbial tip of the iceberg.

We've outlined below NASA's TU Network—named the participants, described their services, and listed the individuals you can contact for more information relating to your specific needs. We encourage you to make use of the information, access, and applications services offered by NASA's Technology Utilization Network.

How You Can Utilize NASA's Regional Technology Transfer Centers (RTTCs) — A nationwide network offering a broad range of technical services, including computerized access to over 100 million documents worldwide.

You can contact NASA's network of RTTCs for assistance in solving a specific technical problem or meeting your information needs. The "user friendly" RTTCs are staffed by technology transfer experts who provide computerized information retrieval from one of the world's largest banks of technical data. Data bases, ranging from NASA's own data base to Chemical Abstracts and INSPEC, are accessible through the six RTTCs located throughout the nation. The RTTCs also offer technical consultation services and/or linkage with other experts in the field. You can obtain more information about these services by calling or writing the nearest RTTC. User fees are charged for information services.

REGIONAL TECHNOLOGY TRANSFER CENTERS (RTTC)

RTTC Directors

NORTHEAST

Dr. William Gasko
Center for Technology
Commercialization
Massachusetts Technology Park
100 North Drive
Westborough, MA 01581
(508) 870-0042

MID-ATLANTIC

Ms. Lani S. Hummel
University of Pittsburgh
823 William Pitt Union
Pittsburgh, PA 15260
(412) 648-7000

SOUTHEAST

Mr. J. Ronald Thornton
Southern Technology Application
Center
University of Florida
College of Eng.
Box 24
One Progress Boulevard
Alachua, FL 32615
(904) 462-3913
(800) 354-4832 (FL only)
(800) 225-0308 (toll-free US)

MID-CONTINENT

Dr. Helen B. Dorsey
Texas A&M University
237 Wisenbaker Engineering
Research Center
College Station, TX 77843-3041
(409) 847-9217

MID-WEST

Dr. Joseph W. Ray
Battelle Memorial Institute
505 King Avenue
Columbus, OH 43201-2693
(614) 424-5522

FAR-WEST

Mr. Robert Stark
Western Research Applications Center
University of Southern California
3716 South Hope Street,
Suite 200
Los Angeles, CA 90007-4344
(213) 743-6132
(800) 642-2872 (CA only)
(800) 872-7477 (toll-free US)

If you are interested in information, applications, research, training, and services relating to satellite and aerial data for Earth resources, contact NASA's transfer point for earth observing technology: Technology Application Center, University of New Mexico, 2808 Central, S.E., Albuquerque, NM 87131-6031; Dr. Stan Morain, Director (505) 277-3622.

If you represent a public sector organization with a particular need, you can contact NASA's Application Team for technology matching and problem solving assistance. Staffed by professional engineers from a variety of disciplines, the Application Team works with public sector organizations to identify and solve critical problems with existing NASA technology. Technology Application Team, Research Triangle Institute, P.O. Box 12194, Research Triangle Park, NC 27709; Dr. Doris Rouse, Director, (919) 541-6980

How You Can Access Technology Transfer Services At NASA Field Centers:

Technology Utilization Officers & Patent Counsels—Each NASA Field Center has a Technology Utilization Officer (Tuo) and a Patent Counsel to facilitate technology transfer between NASA and the private sector.

If you need further information about new technologies presented in NASA Tech Briefs, request the Technical Support Package (TSP). If a TSP is not available, you can contact the Technology Utilization Officer at the NASA Field Center that sponsored the research. He can arrange for assistance in applying the technology by putting you in touch with the people who developed it. If you want information about the patent status of a technology or are interested in licensing a NASA invention, contact the Patent Counsel at the NASA Field Center that sponsored the research. Refer to the NASA reference number at the end of the Tech Brief.

Ames Research Ctr.

Technology Utilization
Officer: Geoffrey S. Lee
Mail Code 223-3
Moffett Field, CA 94035
(415) 604-4044

Patent Counsel:

Darrell G. Brekke

Mail Code 200-11

Moffett Field, CA 94035
(415) 604-5104

Lewis Research Center

Technology Utilization

Officer: Anthony F.

Ratajczak

Mail Stop 7-3

21000 Brookpark Road

Cleveland, OH 44135
(216) 433-2225

Patent Counsel:

Geni E. Shook

Mail Code LE-LAW

21000 Brookpark Road

Cleveland, OH 44135
(216) 433-5753

John C. Stennis Space Center

Technology Utilization
Officer: Robert
Barlow
Code HA-30
Stennis Space Center,
MS 39529
(601) 688-2042

John F. Kennedy Space Center

Technology Utilization
Officer: Thomas M.
Hammond

Mail Stop PT-PMO-A

Kennedy Space

Center, FL 32899
(407) 867-3017

Patent Counsel:

Bill Sheehan

Mail Code PT-PAT

Kennedy Space

Center, FL 32899
(407) 867-2544

Langley Research Ctr.

Technology Utilization
Officer: Joseph J.
Mathis, Jr.
Head, TU & AO Office
Mail Stop 200

10 West Taylor Road,

Hampton, VA 23665-5225
(804) 864-2484

Patent Counsel:

Dr. George F. Helfrich

Mail Stop 143

9A Ames Road,

Hampton, VA 23665-5225
(804) 864-3221

Goddard Space Flight Center

Technology Utilization

Officer: Donald S.
Friedman

Mail Code 702.1

Greenbelt, MD 20771
(301) 286-6242

Patent Counsel:

R. Dennis Marchant

Mail Code 204

Greenbelt, MD 20771
(301) 286-7351

Jet Propulsion Lab.

NASA Resident Office

Technology Utilization

Officer: Arif Husain

Mail Stop 180-801

4800 Oak Grove Drive

Pasadena, CA 91109
(818) 354-4862

Patent Counsel:

Thomas H. Jones

Mail Code 180-801

4800 Oak Grove Drive

Pasadena, CA 91109
(818) 354-5179

Technology Utilization

Officer: Dr. Norman L. Chalfin

Mail Stop 156-211

4800 Oak Grove Drive

Pasadena, CA 91109
(818) 354-2240

George C. Marshall Space Flight Center

Technology Utilization

Officer: Ismail Akbay

Code AT01

Marshall Space Flight

Center,

AL 35812
(205) 544-2223

Fax (205) 544-3151

Patent Counsel:

Robert L. Broad, Jr.

Mail Code CC01

Marshall Space Flight

Center,

AL 35812
(205) 544-0021

Lyndon B. Johnson Space Center

Technology Utilization

Officer: Dean C. Glenn

Mail Code IC-4

Houston, TX 77058
(713) 483-3809

Patent Counsel:

Edward K. Fein

Mail Code AL3

Houston, TX 77058
(713) 483-4871

NASA Headquarters

Technology Utilization

Officer: Leonard A. Ault

Code CU

Washington, DC 20546
(703) 557-5598

Assistant General

Counsel for Patent

Matters: Robert F.

Kempf, Code GP

Washington, DC 20546
(202) 453-2424

A Shortcut To Software: COSMIC®—For software developed with NASA funding, contact COSMIC, NASA's Computer Software Management and Information Center. New and updated programs are announced in the Computer Programs section. COSMIC publishes an annual software catalog. For more information call or write: COSMIC, 382 East Broad Street, Athens, GA 30602 John A. Gibson, Director, (404) 542-3265; FAX (404) 542-4807.

If You Have a Question.. **NASA Center For AeroSpace Information** can answer questions about NASA's Technology Utilization Network and its services and documents. The CASI staff supplies documents and provides referrals. Call, write or use the feedback card in this issue to contact: **NASA Center For AeroSpace Information**, Technology Utilization Office, P.O. Box 8757, Baltimore, MD 21240-0757. Walter M. Heiland, Manager, (410) 859-5300, Ext. 245.

An IR imaging and measurement system that needs no added cooling.

In R&D, NDT, or process monitoring measurements, Inframetrics' 700 Series' longwave IR accuracy makes your work easier, your results surer.

You get superior scan speed and spatial resolution — performance that won't "go south".

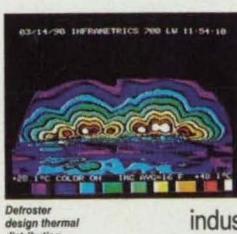
And there's *no LN₂* required. Inframetrics' patented electric microcooler provides more sensitivity, greater resolution, and total freedom in scanner orientation. Design your experiment or test protocol without factoring in liquid nitrogen replenishment...or sacrificing image quality and uniformity.



For your critical applications, there's no substitute for Inframetrics' precision temperature measurement and ultra-sharp imaging.

Other important features? Six measurement modes. Integral 3.5" floppy disk image storage and analysis in lab or field. Color image viewing on a 4" flip-up LCD. Backlit controls. RS232 remote control. And the industry's most versatile post-processing software.

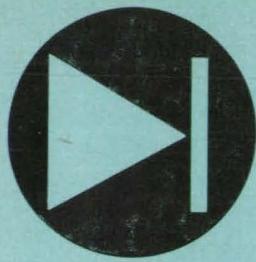
Better still, Inframetrics offers unequalled applications support and training. Call our Commercial Products Division today for 700 Series information.



inframetrics
The Infrared Specialists

16 Esquire Road
North Billerica, MA 01862
Tel: 508/670-5555
Fax: 508/667-2702

Inframetrics Brussels
European Headquarters
Mechelse Steenweg 277, B-1800 Belgium
Tel: 32 2 252 5712
Fax: 358 200 740 760 or 32 2 252 5388



Electronic Components and Circuits

Hardware, Techniques, and Processes

16 Open-Pinned-Phase Charge-Coupled Device

20 Flexible, Thin-Film Solar-Cell Blanket

22 Double-Current-Confining CSP Laser

23 Simple Schlieren Light Meter

Open-Pinned-Phase Charge-Coupled Device

Acceptable quantum efficiency can be obtained without back illumination and back-side thinning.

NASA's Jet Propulsion Laboratory, Pasadena, California

Multiphase charge-coupled devices (CCD's) have traditionally exhibited very poor sensitivity in the ultraviolet (UV), extreme ultraviolet (EUV), and soft x ray spectral regions because of the absorbing polysilicon layers associated with the technology. To bypass the problem, CCD manufacturers have been forced either to thin and back-illuminate the sensor or to deposit UV-sensitive organic phosphor coatings. Virtual-phase CCD technology, however, has resolved the frontside quantum-efficiency (QE) dilemma by leaving half of the pixel element "open," by employing a "virtual electrode" allowing photons to enter into the photosensitive bulk silicon unimpeded.

Unfortunately, unlike multiphase CCD's, virtual-phase detectors have limited usage in low-signal applications because of inadequate charge-transfer efficiency and readout-noise impediments as well as other performance shortcomings. To circumvent these problems, a new CCD technology referred to as "open-pinned-phase" (OPP) was invented to unite the best attributes of multiphase and virtual-phase technologies. The new CCD promises to deliver high front-side sensitivity in conjunction with ultralow-signal-level performance.

In an OPP CCD (see Figure 1) as in a virtual-phase CCD, the collecting phase is

directly exposed, allowing photons to enter the active regions of the semiconductor. The OPP CCD is fabricated by the same process steps as those of a three-phase CCD, except that the third level of poly is intentionally left off. In the third phase, two implants are incorporated in the open region. The first implant adds more phosphorus to the normal n channel, increasing the potential for signal charge to collect. The second implant, a concentrated but very shallow implant of boron, pins the surface potential at the Si/SiO₂ interface to the substrate potential. This pinning implant acts as a virtual gate, maintaining a fixed potential in the bulk silicon beneath the open phase. Both implants are self-aligned by poly levels one and two.

Charge transfer (see Figure 2) for the OPP CCD is accomplished as follows. In transferring charge from the open phase to phase 1, phase 1 assumes a high gate potential. Phase 2 remains at a low potential to act as a barrier to assure that no charge flows backward from the open phase to phase 1. In the next clock cycle, phases 1 and 2 are both biased high, and charge occupies both phases. Phase 1 is then set low, which in turn forces all charge into phase 2. The cycle is finished when phase 2 returns to the low state, and charge moves into the

next open-phase region.

The open phase can be designed larger than the clocked phases to optimize QE performance. The QE of an OPP CCD is relatively high for wavelengths extending from 2,000 to 10,000 Å. The QE drops off rapidly for wavelengths shorter than 2,000 Å because of the absorption properties of the oxide/nitride gate layer. However, if this insulator is etched away, high QE can be achieved to cover an expanded range of 1 Å (soft x ray) to 11,000 Å (near infrared). Still higher sensitivities are possible if an antireflection coating is applied to the open phase, not possible with conventional front-side-illuminated CCD's.

Other attributes of OPP technology include bidirectional clocking (not possible with virtual-phase) and ultralow dark-current generation (for all phases are inverted during integration). Also, the OPP technology is closely related to three-phase CCD technology, which permits most multiphase CCD groups to be fabricated into OPP CCD's without significant change in their processing capabilities.

This work was done by James R. Janesick of Caltech for NASA's Jet Propulsion Laboratory. For further information, Circle 124 on the TSP Request Card.

In accordance with Public Law 96-517,

Figure 1. In this Cross-Sectional View of an 18-μm OPP Pixel, 12 μm are allocated for the open-phase region, and 6 μm for phases 1 and 2. The design is optimized for high QE applications working in the UV, EUV, and soft x ray regions (i.e., the gate insulator has been removed in the open region). (The vertical scale is exaggerated 10 times that of the horizontal.)

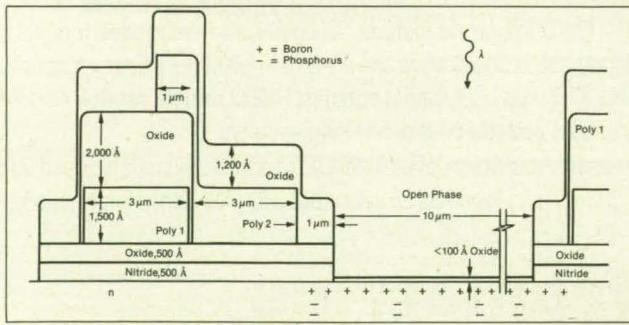
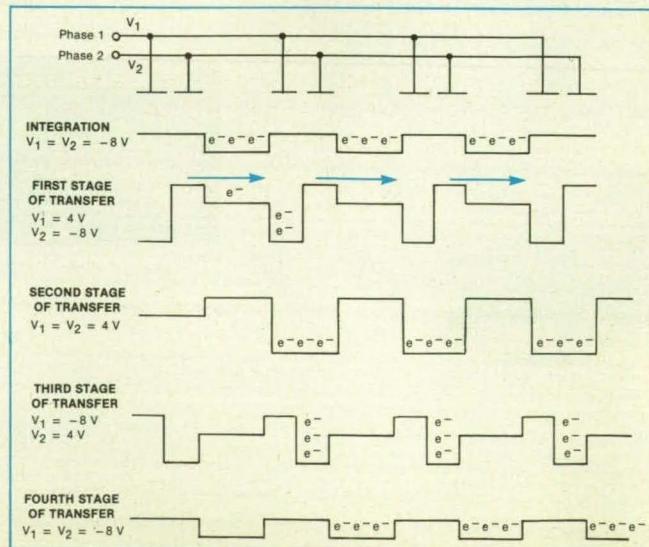


Figure 2. Potential Diagram shows how charge is collected within the open phase during integration and transferred during readout as different clock voltages are applied to phases 1 and 2.



Vision Times

MONDAY, JULY 21, 2121

THE EAGLE I CHRISTENED FOR LAUNCH



A huge crowd gathered to witness the historic ceremony.

By JON LEE

KENNEDY SPACE CENTER, FL (APR.)—The Eagle I, a deep space exploration vehicle, was christened today in a ceremony that dates back over 4,000 years. Appropriate for a ship that's to sail the vast oceans of space, and yet an interesting anachronism for a vehicle so technically advanced.

Making History

"This ship is packed with the latest science has to offer," said Chris Levan, Project Manager for the Eagle I. "But if it weren't for Amoco Performance Products, the Eagle I wouldn't even be here."

Amoco was involved in this challenging project since its beginning. As the only producer of ultra-high modulus pitch-based carbon fibers in the United States at that time, Amoco's participation was crucial.

For example, "all the support struts in the Eagle I are made from THORNEL® P-100 and P-120 pitch-based carbon fiber," explained Levan. "No other material offered us the combination of high modulus, high thermal conductivity and strength. We were able to reduce the weight of the Eagle I by using P-100 and P-120. Plus, the negative CTE of the fiber allowed us to design zero CTE structures. Dimensional stability is very important to us."

The Eagle I bristles with antenna booms, reflectors and sensors—all made with pitch-based carbon fibers. "The ship is loaded with sophisticated technology and electronics of all kinds," said Levan. "The unsurpassed thermal conductivity of THORNEL® pitch-based carbon fiber makes it an ideal material for electronic enclosures and radiator panels."

Amoco had fibers readily available from inventory. Their

Weather

Alpa Patera: Today, cold and clear followed by red dust storms. High 10°C. Tonight, clear. Low -29°C. Tomorrow, chance of meteor showers. High near 20°C. Details, page B12.

\$19.95

responsiveness kept our program right on schedule," Levan

Pride and Excitement

Positioned on the platform and draped with the red, white and blue bunting, the Eagle I glistened in the sunshine as last minute preparations were made.

"It's the blessing of the ship, and a celebration for the thousands of people who worked on this thing," said David Maas, who worked on the navigation systems. "It feels great when you can stand back and see how good she looks."

Champagne, Cheers and Sirens

The crowd cheered and waved flags when the ship was christened with the traditional bottle of champagne. When the bottle broke, thousands of balloons were released, the ship's sirens sounded and a squadron from the elite Rocket Corps screamed past overhead.

And so a new chapter in space exploration begins.

THORNEL® Pitch-Based Carbon Fibers Available Today
THORNEL® pitch-based fibers have been produced at full-scale commercial facilities in the U.S. since 1977. In the 20th century, companies interested in more information on Amoco's immediate supply capability can call 1-800-222-2448.

Mars to be the site of the LVIII Games

After protracted negotiations and intense lobbying, Mars has been designated as the location of the next interplanetary Games. The games are to be known as the Mars Games. The games will be held in Mars' largest city, Olympus Mons, which is already a huge sprawling complex of cities and towns.

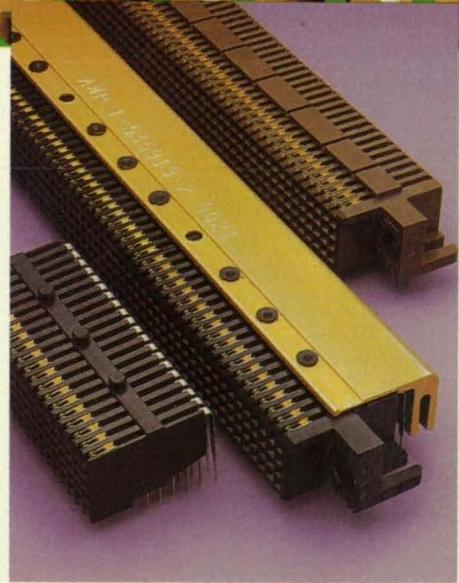
Cont. on Page 14A

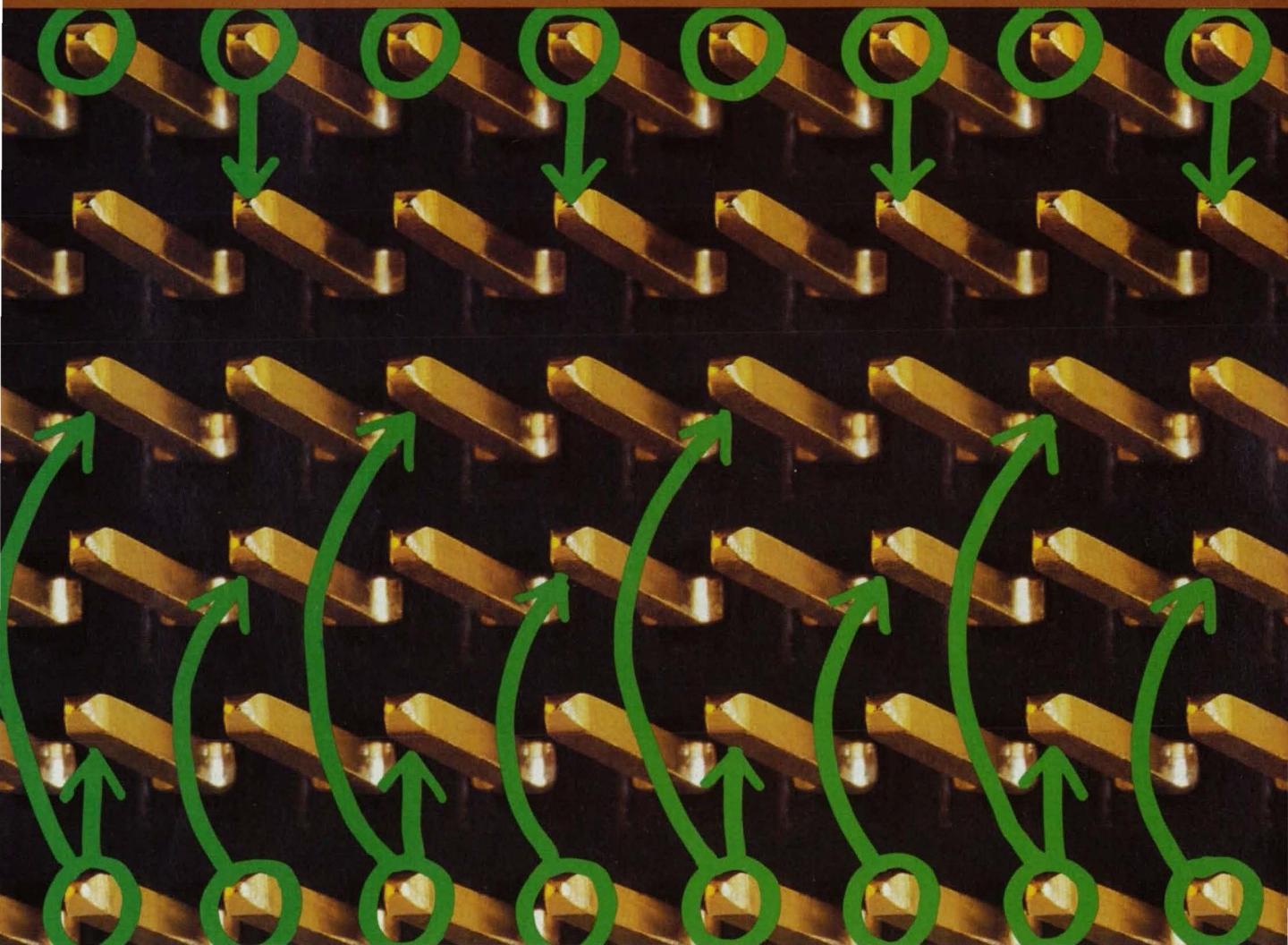
Savoried.

*Our six-row connector
lets you change the ground rules.*



THIS IS AMP TODAY.





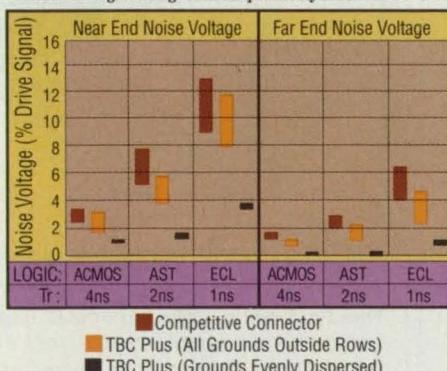
AMP TBC Plus connectors give you complete freedom in ground and signal assignment, so you can write your own 'ground rules' for outstanding electrical performance in high-speed, high-density backplane applications.

Because they are true 6-row connectors and you assign ground where you need it, near end and far end noise voltage figures in the <10 ns risetime range are far below connectors that limit ground to the outer rows or 'planes' (TBC Plus performance is even better when configured the same way!).

Our economical twin-beam receptacle

design is unique in offering greatly reduced inductance in the outermost 'long' row of pins, and matched propagation delay in all lines.

Note performance of AMP TBC Plus connectors with evenly dispersed 'checkerboard' grounding: some competitive styles don't allow this.



Capacitance is a mere 2pf, max, line-to-line.

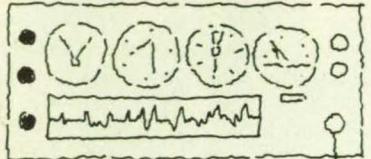
Modular configuration (90- and 120-position sections) provides 'building block' flexibility, with applications to 810 positions or more. Header posts in staggered heights allow four-level sequenced mating.

For the Plus in high-speed performance, call our Product Information Center at 1-800-522-6752 (fax 717-986-7575). AMP Incorporated, Harrisburg, PA 17105-3608. In Canada call 416-475-6222. For design assistance in characterized back-plane assemblies, contact AMP Packaging Systems, 512-244-5100.

Circle Reader Action No. 657

AMP

You've spent millions on your control system,



but if you're using an inferior temperature sensor,



you may find yourself crying in your beer!

RDF CORPORATION's quality engineered sensors have been developed through years of experience in the industrial, nuclear, aerospace and military industries. All of our products are backed with dependable customer service and technical application support. Call us with your specifications and send for our **FREE ITS-90 Computer Disk**.

603-882-5195
FAX 603-882-6925

23 Elm Avenue • Hudson, New Hampshire 03051

the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to Edward Ansell Director of Patents and Licensing Mail Stop 305-6

California Institute of Technology
1201 East California Boulevard
Pasadena, CA 91125

Refer to NPO-17855, volume and number of this NASA Tech Briefs issue, and the page number.



Flexible, Thin-Film Solar-Cell Blanket

Much of the available area is used to absorb solar energy.

NASA's Jet Propulsion Laboratory, Pasadena, California

A proposed blanket of solar photovoltaic cells would be mounted on the exterior surface of the equipment it powers. It would readily conform to irregular shapes. It would not require a separate supporting structure and thus would save space. It would not be added on to the equipment but would constitute an integral part of it.

Such a blanket could be used to recharge a storage battery, for example. It would be wrapped on the outside surfaces of the battery housing and associated equipment, taking advantage of all available surface area for the generation of solar power.

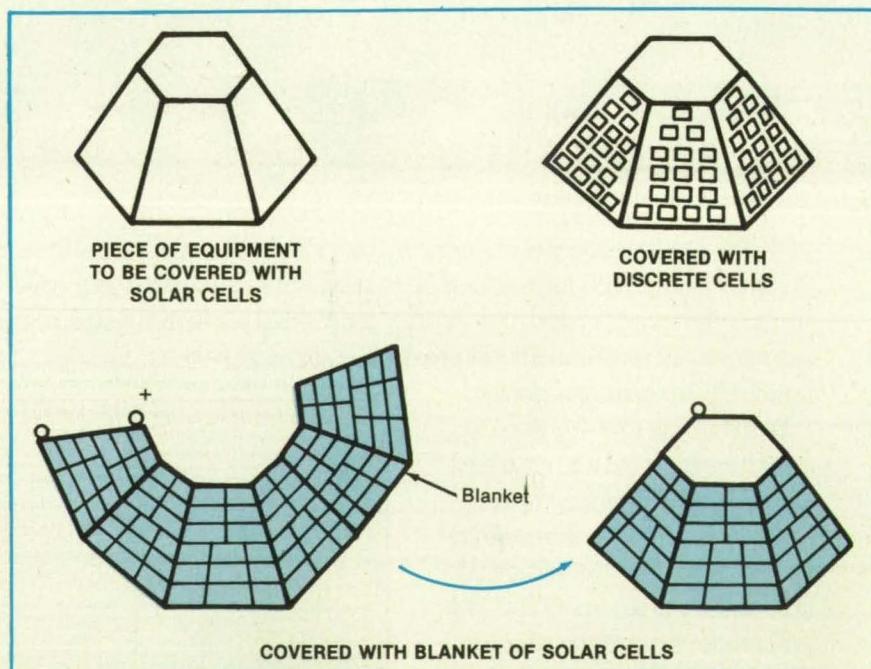
The blanket would contain an array of thin-film photovoltaic cells fitted together edge to edge. Interconnection wiring would be deposited on the sheet photolithographically or by other suitable masking/fabrication methods. The complete blanket, including cells and interconnections, could, if desired, be fabricated as a rigid unit directly on, and supported by, the non-planar surface to be covered. The cost of

such a blanket might be less than that of an array of discrete solar cells. Because the space between discrete cells would be eliminated, a greater fraction of the total area would be available for the absorption of solar energy. Although thin-film cells are less efficient than discrete cells are, the use of all available surfaces and the elimination of space between cells would compensate. Only on purely rectangular surfaces might the discrete-cell-surface-utilization approach that of the irregularly shaped thin-film cell blanket.

The substrate need not be a flexible blanket. It could be jointed stiff panels shaped to suit the housing geometry: triangles, parallelepipeds, segments of circles, and the like. A thin-film photovoltaic circuit would be deposited on each panel.

This work was done by Paul M. Stella of Caltech for **NASA's Jet Propulsion Laboratory**. For further information, Circle 62 on the TSP Request Card.

NPO-18196



Thin-Film Solar Cells, arranged edge to edge on a flexible substrate, would be wrapped around equipment. Arrays of discrete solar cells, in contrast, must be individually mounted and interconnected, with significant space between them.

Announcing a library that's been long overdue.

Introducing BookManager™, an online reference system that replaces traditional manuals and cumbersome reference books. It can put critical information right at your fingertips.

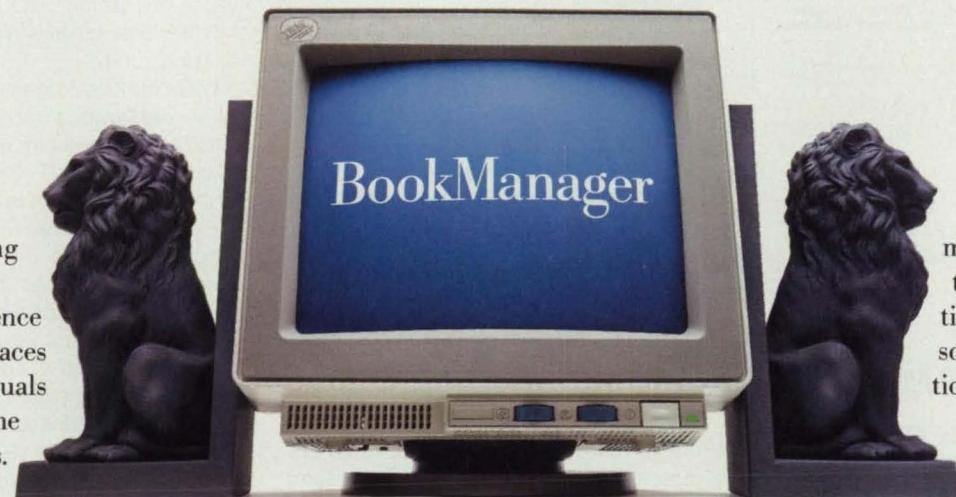
Many companies are using BookManager to turn their vast libraries into electronic "books," helping them save money and space. And you can do the same.

Reference materials are transferred into a highly readable electronic format that helps speed the reader's ability to pinpoint information.

Your electronic books have the characteristics of traditional books (a table of contents, chapters, an index) except one, they never need to become outdated. You can update your information as soon as your information changes.

And reading was never so easy. Our unique linguistic search allows you to find information on a topic simply by entering a word or phrase. Exclusive automatic ranking of search results is provided without reader intervention. The hypertext feature lets you jump from topic to topic quickly, and then allows you to get back to where you started. You can make complete notes right in the margins, and should you want to take your information with you, anything that can be displayed can be printed.

But, most of all, BookManager can save you



money by reducing the cost of production, storage, update, scrap and distribution associated with printed material.

When it comes to finding facts,

BookManager gives a whole new meaning to the term "checking out" your sources of information.

For more information, call 1 800 IBM-6676, ext. 801 or send in the coupon below.

Please send me additional details about:

Solutions for Online Documentation

- Have an IBM marketing representative contact me immediately.
 Send me some free literature.

Clip and mail to:
IBM Corporation, Department 801
P.O. Box 3974, Peoria IL 61614

Or call:
1 800 IBM-6676, ext. 801

Name _____

Title _____

Company _____

Address _____

City _____

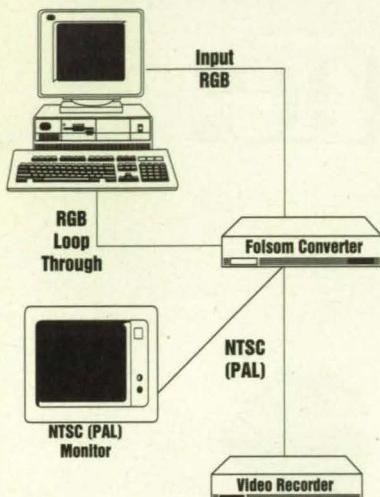
State _____

Zip _____

Phone _____

The IBM logo, consisting of the word "IBM" in its signature blue horizontal stripes.

Convert Any High-Res Video to TV Formats!



We Can Convert Anyone

With over 20 years experience, Folsom Research has built a worldwide reputation for superior products and leading-edge technology. Our products are currently used by most Fortune 500 companies.

Several models are available. Product features include

- Video frame grab.
- Digital frame buffer access.
- Support for multiple workstations.
- On-board V-LAN™ for controlling single-frame recorders, videodisks, and editing systems.
- Medical, video, and radar products available.

Call Us to Find Out Which Product Will Convert You!



526 East Bidwell Street
Folsom, CA 95630
tel: 916.983.1500
fax: 916.983.7236

Double-Current-Confining CSP Laser

A second p/n junction increases differential quantum efficiency.

Langley Research Center, Hampton, Virginia

In spaceborne communications systems, the output emission wavelengths of lasers are chosen to be about 870 nm to avoid absorption of the emitted light by the atmosphere when communicating with ground-based terminals. Improved channeled-substrate-planar (CSP) lasers that emit at wavelengths between 860 and 880 nm have been grown by liquid-phase epitaxy (LPE). These lasers exhibit record high output powers and efficiencies, which are attained without sacrifice of desirable characteristics of the lasers.

Heretofore, in the fabrication of such a laser, a deep zinc diffusion has been performed to focus the current to the lasing area within the laser structure. This works well, but there is still some spread of the current outside the lasing area. This spread wastes some of the current, and the laser consequently operates at higher current and lower efficiency than it potentially could. Improvements could be realized if all the current could be effectively used for lasing within the laser structure.

In the fabrication of a CSP laser of the improved type, a second reverse-bias p/n junction is incorporated to reduce the required current. Such a junction permits current to flow in one direction in the laser. By incorporating two reverse-bias junctions in the CSP structure, one doubly confines the current. Thus, the structure of the improved lasers is called "double-current-confined CSP" or "DCC-CSP" (see figure).

The light generated in the active layer is absorbed in the current-blocking layer or the second reverse-bias junction, resulting in the generation of electron/hole pairs. Thus, the thickness of the layer must be larger than the minority-carrier diffusion length. If the thickness of this layer is less, minority carriers diffuse away from the blocking layer, resulting in an accumula-

tion of majority carriers and a reduction in the barrier potential. As a result, current is permitted to flow through this layer. If the thickness of this layer is greater than the minority-carrier diffusion length, electrons and holes recombine in the layer, and the barrier to current is maintained.

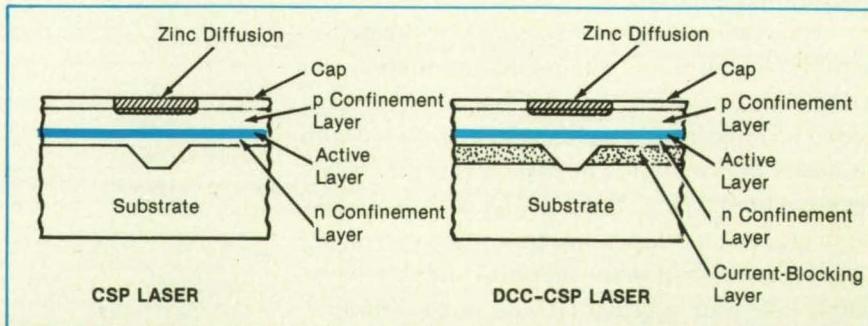
The incorporation of the second p/n junction in the laser structure requires the addition of a second growth step to the fabrication process. This growth step is best effected by metalorganic chemical vapor deposition (MOCVD). In addition, MOCVD enables growth on multiple wafers at once.

Laser devices containing DCC-CSP structures displayed a modest improvement in differential quantum efficiency over that of conventional CSP lasers, without any change in the desirable operating characteristics of the device. Operation in a single longitudinal mode was obtained at the same peak wavelength in both continuous-wave and 50-percent-duty-cycle excitations. These lasers would be used eventually as sources of light in intersatellite communications systems and, specifically, the NASA Advanced Communications Technology Satellite (ACTS) System.

This work was done by John C. Connolly of the David Sarnoff Research Center for Langley Research Center. Further information may be found in NASA CR-4238 [N89-23860], "High-Power Single Spatial Mode AlGaAs Channeled-Substrate-Planar Semiconductor Diode Lasers for Spaceborne Communications."

Copies may be purchased [prepayment required] from the National Technical Information Service, Springfield, Virginia 22161, Telephone No. (703) 487-4650. Rush orders may be placed for an extra fee by calling (800) 336-4700.

LAR-14200



The Blocking Layer in the DCC-CSP laser increases efficiency over that of the CSP laser.

Simple Schlieren Light Meter

The positions of schlieren knife edges can now be adjusted objectively and accurately.

Langley Research Center, Hampton, Virginia

Schlieren optical systems are often used to observe or photograph perturbations in the refractive indices of compressible media; e.g., to make the flow of air visible in a wind tunnel. More than 20 schlieren systems dedicated to specific facilities, as well as numerous temporary systems, are in use at NASA Langley Research Center. However, since the advent of schlieren systems, the amount of cutoff of the knife edge in each system has been adjusted subjectively, and this practice has been the source of many problems.

The knife edge should be positioned at a focal point so as to obstruct half the light. Such a 50-percent cutoff makes the schlieren system equally sensitive to deflections either toward or away from the knife edge. In practice, the amount of cutoff of the knife edge has been set for the correct photographic exposure instead of for blocking half the light. Setting the knife edge objectively at the proper position will increase the repeatability of the system, independent of any bias of the operator.

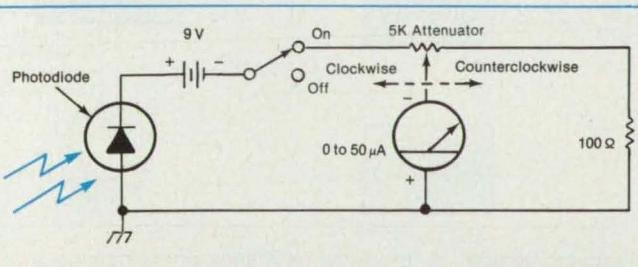
The figure is a schematic circuit diagram of a new instrument for aligning a schlieren system. A microammeter measures the current from a photodiode that is reverse-biased to produce a linear output current as a function of the intensity of light. An on/off switch is provided to disconnect the battery when the instrument is not in use. A potentiometer is connected as an attenuator to vary the sensitivity of the instrument.

In operation, the unit is turned on with the attenuator set fully counterclockwise to minimum sensitivity. The photodiode is placed in an unblocked portion of the light cone behind the position of the knife edge. The knife edge is initially adjusted to no cutoff. The attenuator is turned clockwise until the meter reads full scale, which is, in this example, 50 μ A. If a full-scale reading is not possible, the peak reading is used. Next, the knife edge is advanced across the beam, increasingly cutting it off (causing the reading of the meter to decrease). When the meter reads half the full-scale or peak reading, the knife edge has reached its proper position. The photodiode should then be removed from the optical path, and the instrument turned off until it is to be used.

When the knife edge is thus properly positioned, exposure can be controlled by varying the brightness of the source of light, varying the shutter time, and/or using neutral-density filters. The exposure should not be changed by varying the cutoff of the knife edge because doing so diminishes the value of the resultant photograph in that it does not indicate deflections toward or away from the knife edge with equal sensitivity.

The use of the schlieren light meter enables the operator to check quickly the position of the knife edge between tunnel runs to ascertain whether or not the schlieren system is in alignment. A permanent measuring system can be made a part of each schlieren system. If placed in an unused area of the image plane, or in a monitoring beam from a mirror knife edge, it can provide real-time assessment of the alignment of the schlieren system.

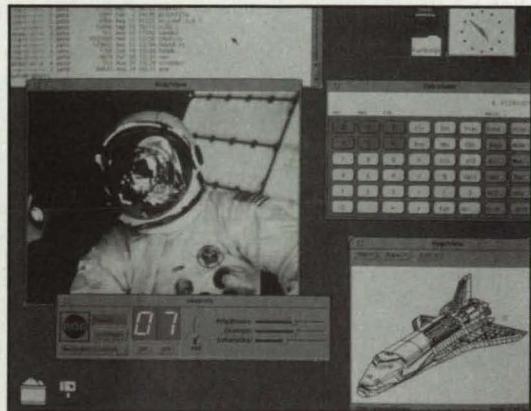
This work was done by David B. Rhodes, John M. Franke, Stephen B. Jones, and Bradley D. Leighty of Langley Research Center. No further documentation is available. LAR-14249



This Simple Light-Meter Circuit is used to position the knife edge of a schlieren optical system to block exactly half the light, reducing the inaccuracies caused by the previous subjective technique for the alignment of knife edges.

NASA Tech Briefs, January 1992

Real Time Video On Workstations



The RGB/View System for Mission Critical Applications

The RGB/View™ displays live TV or other full motion video on workstations and high resolution displays. The RGB/View accepts video signals (NTSC or PAL) from a camera, tape recorder, videodisc or built-in TV tuner. FLIR input is also available. True color video is displayed full screen or as a scaleable window.

- Real time video under all conditions
- No impact on graphics performance
- Image capture
- Text and graphics overlays on video
- Scale, reposition, freeze
- X-Windows compatible
- Cable ready tuner
- Priced from \$7500.00

Applications include C3I, robotics, interactive videodisc training, video teleconferencing, process control, surveillance and simulation.

Standalone peripheral and board level models available.



950 Marina Village Parkway Alameda, CA 94501
Tel: (510) 848-0180 Fax: (510) 848-0971

INFOCOMM Booth #381
Circle Reader Action No. 468



Electronic Systems

Hardware, Techniques, and Processes

24 Stepping-Motion Motor-Control Subsystem for Testing Bearings

24 Monitoring Subsystem for Testing Bearings

Books and Reports

25 Environmental Tests of Cesium Frequency Standards

25 Detecting Latent Faults in Digital Flight Controls

28 Resolution of Phase Ambiguities in QPSK

Stepping-Motion Motor-Control Subsystem for Testing Bearings

Bearings and motors can be made to undergo realistic motions for testing.

Goddard Space Flight Center, Greenbelt, Maryland

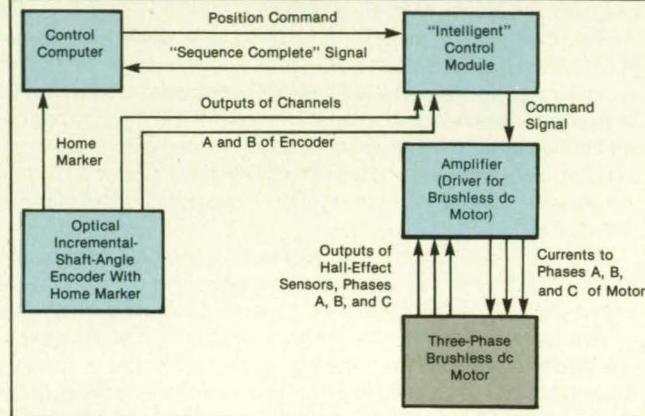
A developmental general-purpose electronic controlling and monitoring system is designed to test rotary instrumentation bearings by subjecting them to stepping motions like those in the intended applications. It can also be used to test bearing-and-motor assemblies, motors, angular-position sensors that include rotating shafts, and the like. The control subsystem can enforce a variety of low- and high-speed continuous and/or stepping motions similar to those of scanning instruments and filter wheels. The monitoring subsystem gathers data that can be used to evaluate the performance of the bearing or other article under test. The monitoring subsystem is described in more detail in the following article, "Monitoring Subsystem for Testing Bearings" (GSC-13432).

The control subsystem (see figure) includes a three-phase brushless dc motor that drives the bearing under test (other motors could be used). It also includes an optical shaft-angle encoder (to measure the angular position in limited or unlimited rotary motion) or a rotary variable-differential transformer (to measure the angular position over a limited range). Thus, it is a closed-loop angular-position-control sub-

The Control Subsystem is a closed-loop angular-position-control system that can cause the motor and the bearing under test to undergo any of a variety of continuous or stepping motions.

system and, as such, has the versatility to generate the required variety of stepping or continuous motions.

In addition to the motor and angular-position-measuring equipment, the control system includes a computer, an "intelligent" control module, and an amplifier that energizes the coils of the brushless dc motor. Because the control module does not contain a buffer that could store a sequence of position commands, the computer is made to send position commands continuously via an RS-232-C communication line to the control module. The control module uses these commands to



generate output voltages that are converted into motor currents by the amplifier. The control module uses the output from the encoder as position feedback. The control module also includes a lead-lag compensator with programmable pole, zero, and gain. Three digital Hall-effect sensors mounted on the motor provide the commutation signals for the amplifier.

This work was done by Charles E. Powers of Goddard Space Flight Center. For further information, Circle 164 on the TSP Request Card.

GSC-13418

Monitoring Subsystem for Testing Bearings

The performances of bearings and motors undergoing realistic motions can be measured.

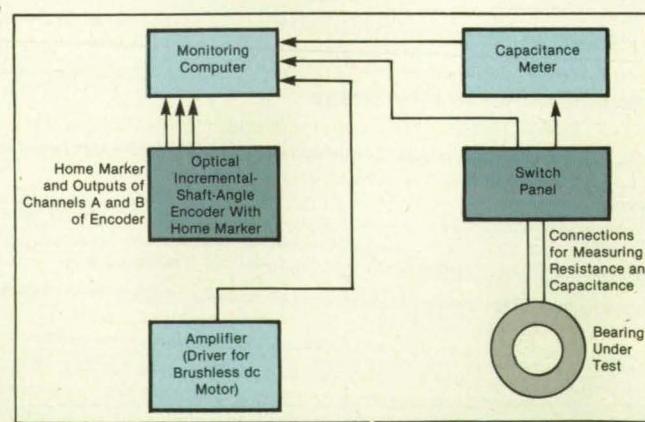
Goddard Space Flight Center, Greenbelt, Maryland

An electronic monitoring subsystem is designed to be used in conjunction with the controlling subsystem described in the preceding article, "Stepping-Motion Motor-Control Subsystem for Testing Bearings" (GSC-13418). The monitoring subsystem gathers data that can be used to evaluate the performance of a bearing motor or other rotary mechanism that is being tested by subjecting it to stepping motions like those in its intended application. The data are gathered at a rate high enough to characterize the dynamic properties of the mechanism.

The monitoring subsystem (see figure) is built around a computer with an analog-to-digital interface card. The computer executes a program that was written for

The Monitoring Subsystem gathers data on the angular position, angular speed, capacitance, and resistance of the bearing under test.

instrument-control and monitoring applications. A capacitance meter is also a part of the monitoring system. During a test, the motor current, the capacitance and



electrical resistance of the bearing, and the output of the shaft-angle encoder will be monitored.

Each of these quantities will be sam-

pled at rate of 8 kHz during several cycles of the stepping pattern. The motor current and the angular position and velocity derived from the output of the encoder will be used to calculate bearing friction. The bearing-friction and angular-position data will be used to determine whether the bearings meet the failure criteria. The resistance and capacitance data will be used to determine whether the bearings are lubricated and, if so, possibly the thickness of the lubricating film. The data may also be subjected to other types of analysis; e.g., power spectra could be extracted.

This work was done by Charles E. Powers of Goddard Space Flight Center. For further information, Circle 39 on the TSP Request Card. GSC-13432

Books and Reports

These reports, studies, handbooks are available from NASA as Technical Support Packages (TSP's) when a Request Cardnumber is cited; otherwise they are available from the National Technical Information Service.

Environmental Tests of Cesium Frequency Standards

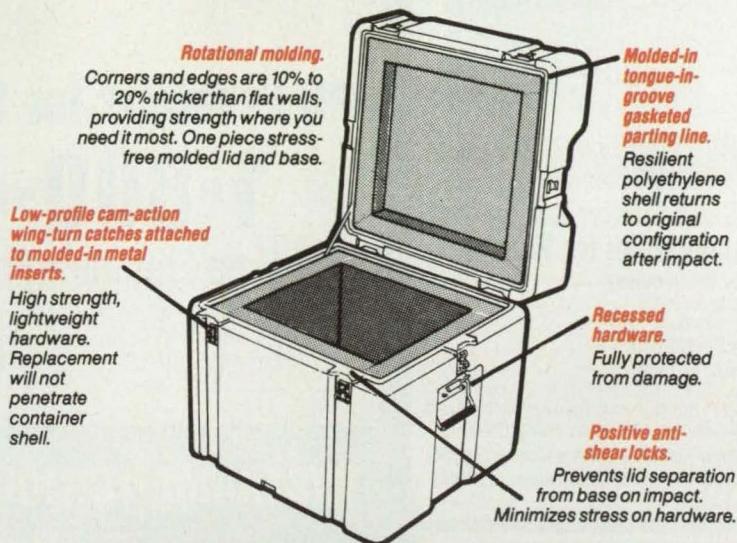
Humidity affected all units, but not in the same way.

A report describes environmental tests of cesium-beam frequency standards of the United States Naval Observatory. The purpose of the tests, conducted in the Frequency Standards Laboratory of NASA's Jet Propulsion Laboratory, was to determine the effects of atmospheric temperature, relative humidity, and pressure on the frequencies.

Four standards were first stabilized for a few days in the temperature-controlled laboratory environment, then degaussed, aligned, and examined for conformance with the manufacturer's specifications. For the measurements of frequencies, the standards were placed in environmental chambers wherein each of the three environmental parameters was varied while the other two were held constant. Each combination of parameters was maintained for 1 day. The temperature range used in these tests was 17 to 33 °C, the relative-humidity range was 15 to 85 percent, and the barometric-pressure range was ± 24 in. of water (± 5.4 kPa). Unit 1 failed shortly after measurements were begun, and the tests were continued with units 2, 3, and 4.

The barometric pressure was found to have no significant effect on the frequencies. However, the effects of temperature and humidity could be seen in measurement data plotted as frequency versus relative humidity at constant temperature and as frequency versus temperature at constant relative humidity. Unit 2 exhibited the largest changes in relative frequency (as

FOR A TOUGH CASE GET HARDIGG™



Lightweight, MIL-SPEC off-the-shelf protection against shock, vibration, moisture, temperature extremes.



HARDIGG™ CASES
A Division of Hardigg Industries, Inc.

1-800-843-2687

393 No. Main Street, P.O. Box 201, South Deerfield, MA 01373 (413) 665-2163 FAX: (413) 665-8061

Circle Reader Action No. 492

much as 4×10^{-13} over the ranges of environmental parameters); units 3 and 4 exhibited somewhat smaller changes.

All three of the functioning standards showed marked sensitivity to humidity, but the magnitude and sign of the change in frequency vs. change in relative humidity was not the same for all standards. When the data were replotted as frequency versus absolute humidity, units 2 and 3 showed a clear trend of frequency decreasing with increasing water content, while unit 4 exhibited more-anomalous behavior, with frequency mostly decreasing with increasing water content above a temperature of 30 °C and mostly increasing with increasing water content below 30 °C.

The practical implication of the data is that, if frequency stability of 10^{-14} is to be obtained from cesium frequency standards of the type tested, not only must the temperature be controlled to a level of about ± 0.1 °C, but control of humidity is essential. It appears that, at a nominal relative humidity of 35 percent, the humidity control must maintain a stability of about ± 2 percent.

This work was done by Richard L. Sydnor, Thomas K. Tucker, Charles A. Greenhall, William A. Diener, and Lutfollah Maleki of Caltech for NASA's Jet Propulsion Laboratory. To obtain a copy of the

report, "Environmental Tests of Cesium Beam Frequency Standards at the Frequency Standards Laboratory of the Jet Propulsion Laboratory," Circle 60 on the TSP Request Card. NPO-18273

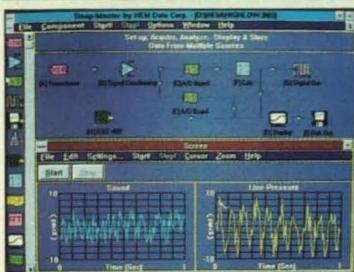
Detecting Latent Faults in Digital Flight Controls

The efficacy of statistical detection of faults is assessed.

A report discusses the theory, conduct, and results of tests that involved the deliberate injection of low-level faults into a digital flight-control system. These tests were part of a study of the effectiveness of techniques for the detection of and recovery from faults, based on the statistical assessment of inputs and outputs of parts of control systems. These statistically based fault-detection and recovery techniques are expected to offer an exceptional new capability to establish the reliabilities of critical digital electronic systems in aircraft.

Most digital flight-control systems include built-in self-testing and/or comparative monitoring of redundant outputs to detect and correct faults up to the required levels of reliability. However, a fault

SOFTWARE



NEW Snap-Master Software: Data Acquisition for Windows

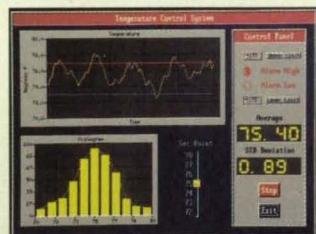
Discover Snap-Master — the only Windows-based data acquisition and analysis software to achieve high-speed, real-time data acquisition with multiple simultaneous A/D boards.

Snap-Master lets you define your own custom instruments using icons and easy-to-understand flow charts. A pre-defined database of sensors is integrated with the data acquisition system.

#HDS 200 Snap-Master Acquisition Module.....\$995

#HDS 210 Snap-Master Analysis Module\$495

Use modules as an integrated package or stand-alone



LabWindows 2.0 Menu-Driven Instrumentation Software

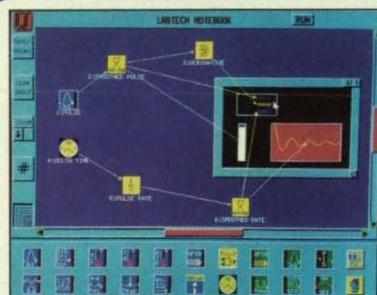
With **LabWindows 2.0** you get the best of both worlds: the ease-of-use of a menu-driven package combined with the flexibility possible only when you write your own code. The menu interface takes you step-by-step through the process of configuring the data acquisition, analysis, and display portions of your system.

It then compiles your setup into C or QuickBASIC code. This is the easiest way to create data acquisition and analysis programs!

#NIS 473 LabWindows 2.0 Software\$695

#NIS 474 LabWindows Advanced Analysis.....\$895

#NIS 475 LabWin. Acquis. + Analysis (both)..\$1395



Labtech Notebook Software: The Industry Standard

Labtech Notebook is the undisputed industry standard for real-time data acquisition & display. Famous for its ease of use, the new ICONview mouse-driven interface has made Notebook even easier to set up and use. Data may be acquired in the background while your PC runs other applications (such as data analysis), for uninterrupted runs up to several weeks in length.

#INST 200 Labtech Notebook Ver 6 Software with ICONview Easy-to-Use Interface\$995

CyberResearch

JANUARY PRODUCT SHOWCASE

PC Products for Scientists & Engineers

1-800-486-8800

Toll-Free Hotline • Free Application Engineering



INSTRUMENTATION



Digital Products DataCommander

New **DataCommander™** Serial Port Multiplexers operate independently of your host PC. Achieve high-speed data collection and communications from many sources without taxing your PC's main processor. On-board 250K memory buffer (upgradeable to 4MB) and on-board microprocessor make the DataCommander™ a powerful acquisition tool. **Your PC can be executing other tasks while the unit spools up to 4MB of incoming data.**

Ports on these units use DB 25-pin connectors.

Custom configurations are available featuring RS-422 (long distance) lines, RJ-11 / RJ-45 connectors, and parallel port options.

#DCOM 600 6-Port RS-232 DataCommander".....\$995

#DCOM 1000 10-Port RS-232 DataCommander"....\$1495

#DCOM 1610 16-Port RS-232 DataCommander"....\$1995

PC SYSTEMS



Elma Rack-Mount Keyboards

If you use a standard keyboard with your rack-mounted system, you know what a nuisance and a hazard it can be. These new industrial keyboards are designed to fit easily into any EIA 19" rack. Rugged and reliable, these keyboards are made in the U.S.A. by a Swiss company and demonstrate classic Swiss craftsmanship.

- Full 101-key layout.
- Full-travel construction with excellent tactile feel for touch-typing.
- **OIX 3010** keyboard is set in a drawer (not shown).
- **OIX 6010** keyboard slides out w/ a locking door.
- Occupies only 1 rack space (1.75" high).

#OIX 3010 Rack-Mount Keybd — 24" D Rack....\$295

#OIX 6010 Rack-Mount Industrial Keyboard.....\$395



Arnet Intelligent Serial Boards

Your PC is no longer limited to 2 serial ports!

Multi-port serial boards from Arnet let your DOS-based PC support up to 66 serial ports. All Arnet boards come complete with DOS Driver Software and an external 25-pin "D" connector box.

- Intelligent units offer on-board 80186 microprocessor and dual-ported RAM buffer.

- **Free** DOS driver software lets DOS recognize up to 66 COM: ports.

- **SurgeBlock™** on all ports protects your PC from killer voltage spikes.

- **"Rock-Solid" Lifetime Warranty.**

#COMH 104 4-Port Intelligent Serial Board.....\$595

#COMH 108 8-Port Intelligent Serial Board.....\$995

#COMH 116 16-Port Intelligent Serial Board...\$1895

#COMH 132 32-Port Intelligent Serial Board...\$2995



NEW! Rack-Mount PC's with built-in VGA Monitors

CyberResearch carries the broadest line of rack-mount and industrial computers. Now we've added new models with built-in VGA monitors. You get a compact unit with '386 power and a color display.

- Built-In 10" VGA Color Monitor & VGA Card
- 4 Megabytes of RAM (2MB for the VRC 386-16S)
- Enhanced 101-Key Keyboard
- 1.2MB Floppy Drive (or 1.44/3.5" if preferred)
- 2 Serial RS-232 Ports & 1 Parallel Printer Port
- DOS 3.3 Software (or DOS 5.0, if preferred)

#VRC 386-16S VGA Rack-Mt. PC, 80386SX, 16MHz \$3595

#VRC 386-33 VGA Rack-Mt. PC, 80386, 33MHz..\$4995

#VRC 486-33E VGA Rack-Mt. EISA, '486, 33MHz..\$6995

DATA ACQUISITION

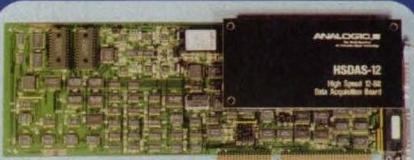


1 MHz 12-Bit ComputerScope Offers Unique Advantages

The ComputerScope High-Speed Data Acquisition System from **RC Electronics** includes a 1MHz A/D board, a BNC Terminal Panel, and Digital Oscilloscope Software. A specially-designed series of software modules provides tightly-integrated *real-time* performance. Call us for detailed information on the EGAA software system.

- Sixteen 12-bit Analog Input Channels.
- 64K-Sample Buffer for Maximum Performance.
- Supports Pretriggering Sample Mode.
- Comes complete with ComputerScope Software.

#INST 601 1MHz ComputerScope System\$2495
#INST 805 EGAA Multi-Tasking Software\$795
#INST 615 Electronic Chart Recorder & AutoDisk Data Logging Software Modules...\$1195



DAS Boards with DMA offer Data Acquisition to 400 KHz

Our selection of high-performance A/D boards from **Analogic** allow continuous data acquisition. Direct Memory Access (DMA) allows these boards to transfer data directly to your PC's memory at high speed. For use in AT or EISA-bus PC's only. The 16-bit boards offer the greatest resolution (1 part in 65536), while the HSDAS 12 resolves to 1 part in 4096. Boards are supplied with utility software, and are fully supported by *Snapshot*, *SnapMaster*, & *Asyst* software packages.

#HSDAS 12 400 KHz, 12-Bit Data Acquisition Board with High-Speed DMA.....\$2295
#HSDAS 16 200 KHz, 16-Bit High Resolution AT Data Acq. Board w/High-Speed DMA....\$1695
#LSDAS 16 50 KHz, 16-Bit High Resolution AT Data Acq. Board w/High-Speed DMA\$1395

VGA to your VCR



Redlake TapeCaster VGA to Video Converter

Redlake's **TapeCaster** converts VGA screen output to video for applications such as animation and creating training tapes. The TapeCaster is extremely easy to use: no base addresses, no interrupts, no software — just plug and play.

- True, precise NTSC or PAL video timing.
- Simultaneous VGA and video display.
- Composite Video & Y-C (SuperVHS) output for use with equipment ranging from an inexpensive VCR to broadcast-quality professional video.

#NTSC 200 TapeCaster - NTSC Video Output\$750
#PAL 200 TapeCaster - PAL (Europe) Video Out ...\$750
#NTSC 100 Spectrum-NTSC Video Digitizer and VGA Overlay Controller with software.....\$1650



Intelligent Remote Processors from Analog Devices

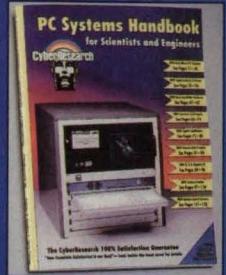
Now you can distribute your data acquisition power to wherever it is needed. Our new remote acquisition units will operate anywhere you have data to collect. And compatibility with popular software makes setup a snap.

- RS-232 & RS-485 Communications Interfaces.
- 16 Single-Ended or 8 Diff. Analog Inputs.
- Resolution Selectable from 13 to 18 bits.
- On-board 801C88 microprocessor.
- **RDAS 1050** runs with host PC supervision
- **RDAS 1060** designed to run stand-alone.

#RDAS 1050 Intelligent Remote DAS Unit.....\$995
#RDAS 1060 Intelligent Remote DAS Computer....\$1395

FREE! Combination Catalog / Tutorial

The CyberResearch **PC Systems Handbook for Scientists and Engineers** describes over 1400 unique and hard to find items for PC-based engineering. Packed with useful technical information & easy-to-read diagrams, this detailed and invaluable reference should be part of every engineer's library. For a complimentary copy of this unusual catalog and reference guide, call (800) 486-8800 or (203) 483-8815.



The **PC Systems Handbook** is available outside the United States for \$14.95US, prepaid, including surface delivery (allow 2-4 weeks). Send \$19.95US for express airmail delivery.

Circle Reader Action No. 371

MOTION CONTROL



MOTION CONTROL SYSTEM Makes motor control easy.

PC-based motion control may seem like science fiction to many people. Here at CyberResearch, it's one of our specialties. It can also cost a lot less than you think. Shown here is our **CMCS 222A** complete motor control system, which includes:

- **Technology 80** 2-Axis Intelligent Stepping Motor Controller board complete with software.
- **Oriental Motors** High-Torque Stepping Motors, Size 23, 1.8°/Step (Qty 2)
- **IMS** 40V, 3.5A Bipolar Chopper Drivers (Qty 2)
- **Electrostatics** Regulated DC Power Supply
- Terminal Panel and Cabling

#CMCS 222A High Torque, Dual-Motor, PC-based Stepping Motor Control System\$1595

Wide Selection of Products

When you need PC-compatible equipment for science and engineering, there's only one name to think of: **CyberResearch**. We offer the largest selection of hardware and software for data acquisition, instrumentation, communications, motion control, etc. We stock all your best-known suppliers like those featured on these pages and many more.

It's Easy to Order

We accept Purchase orders from:

- Companies with an established credit account.
- Government Agencies
- Fortune 500 companies
- Universities and hospitals

If you don't fall into one of these categories, you can place orders prepaid (credit card / check) or COD with a company check.

CyberResearch

Worldwide
(203) 483-8815
Fax: (203) 483-9024

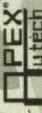


TOLL-FREE HOTLINE
(800) 486-8800

Mailing Address: P.O. Box 9565
 New Haven, CT 06535-0565

1883 POWER AND HIGH VOLTAGE AMPS

Apex has long been the leader in power and high voltage amplifiers. Even better, Apex is the leader in 1883 compliant, military grade amplifiers. If you need a source for MIL-STD-1772 certified and qualified amplifiers—screened to MIL-STD-883—all you need to know is Apex (see chart at right). All Apex models listed are SMD (Standardized Military Drawing) compliant. 100 percent factory tested. Proven in production. Product availability is just a matter of a phone call.



APPLIED TO INTEGRATED

APPEX[®]
MICROTECHNOLOGY CORPORATION
5980 N. SHANNON ROAD, TUCSON, ARIZONA 85741

For Product Availability To Place An Order Call (602) 742-8601

Apex Model No.	SMD Part No.
High Power PA02M/883	59629067901HXC
PA07M/883	59629063801HXC
PA10M/883	59629065901HXC
PA12M/883	59629062801HXC
PA51M/883	59628782002YC
High Voltage PA08M/883	59629072301HXC
PA83M/883	596296101HXC
PA84M/883	59629073601HXC
High Speed PA09M/883	Contact Apex for status

To Obtain Immediate Product Information Call 800-448-1025 or FAX (602) 888-3329

may not become apparent through comparative monitoring or be recognized at the outputs of a component until the faulty component is used. Consequently, the fault could remain latent for a long time, all the while creating a probability that the system could fail in the event of an operation that depends on that component.

In the tests, a digital instrumentation system was used to inject 2,715 "stuck at" and "invert" faults at the level of pin contacts of devices of the data path and control cards of a dual/dual flight-control computer. Faults were detected by comparators located in the secondary actuator-drive electronics or by self-testing. The results of the tests are assessed statistically to ascertain the implications for the reliability at the system on the basis of a mathematical model of the statistical behavior of the system in the presence of single faults. The extension, in principle, to statistical models for multiple faults is also discussed briefly.

Most tests were done on an open-loop basis. However, the more-persistent faults were subjected to closed-loop-simulator tests to involve explicit fault-detection mechanisms. The results of the tests were found to be in reasonable accord with those of prior tests that involved different testing and tested equipment. The results of the tests were found to agree with the mathematical models of the faults in question and to indicate the value of this type of testing in practical efforts to validate the tested systems.

This work was done by John McGough of Allied/Bendix, Dennis Mulcare of Lockheed/Georgia, and William E. Larsen of the Federal Aviation Administration for Ames Research Center. To obtain a copy of the report, "A Method of Measuring Fault Latency in a Digital Flight Control System," Circle 17 on the TSP Request Card. ARC-12333

Resolution of Phase Ambiguities in QPSK

Advantages and disadvantages of several techniques are described.

A report discusses several techniques for the resolution of phase ambiguities in the detection and decoding of radio signals modulated by coherent quadrature phase-shift keying (QPSK) and offset QPSK (OQPSK). There are eight such ambiguities: four associated with the phase of the carrier signal in the absence of ambiguity in the direction of rotation of the carrier phase, and another four associated with the carrier phase in the presence of the phase-rotation ambiguity.

Depending on the specific QPSK or OQPSK modulation scheme and data format, the specific coding and decoding schemes and the applicable technique for the resolution of phase ambiguities can be

classified as differential or nondifferential. In a differential system, the information is conveyed by changes in phase that are attributable to modulation (without having to determine the carrier phase at the receiver), whereas in a non-differential system, the information is conveyed by the actual phase relative to the carrier phase. For an uncoded system, the combination of a nondifferential decoding technique and the applicable phase-ambiguity-resolving technique can be described as a unique-word detection technique. For a coded system, the combination of a non-differential decoding technique and the applicable phase-ambiguity-resolving technique can be regarded as a threshold decoder technique and as a unique-word detection technique.

The effects of differential and unique-word techniques on prior uncoded and coded QPSK and OQPSK modulation systems are discussed briefly. Attention is then focused on a technique developed by the author and one version of which was described in "Resolving Phase Ambiguities in OQPSK" (NPO-17853), *NASA Tech Briefs*, Vol. 15, No. 7 (1991), page 30. In this technique, a carrier-tracking loop integrated with a symbol synchronizer resolves four of the phase ambiguities, while unique-word detection by use of synchronization signals resolves the remaining four phase ambiguities. In an alternative version, a synchronizing circuit is inserted between the output of a QPSK demodulator and the input of a threshold decoder of a type that can correct a predetermined number of bit errors in a coded stream of bits. The alternative version does not require unique words or synchronization signals to resolve the phase ambiguities.

The report concludes by making the following recommendations:

1. Differential coding (without any other coding) should be used only when there is some way to prevent the "double-error" phenomenon (errors almost always occurring in pairs) that is typical of the outputs of differential decoders (in the absence of any other coding/decoding). This technique is suitable for burst-mode signals.
2. The unique-word version of the author's technique, which can utilize existing synchronization signals, is highly recommended for QPSK and OQPSK modulation systems.
3. The threshold-decoder is recommended only for a system that has to operate within a narrow frequency band.

This work was done by Tien M. Nguyen of Caltech for NASA's Jet Propulsion Laboratory. To obtain a copy of the report, "Techniques To Resolve Phase-Ambiguity and the Impacts of These Techniques on QPSK Modulation Systems," Circle 117 on the TSP Request Card. NPO-18083



Signal creation and analysis enters a new domain: the real world.

WaveForm DSP™ closes the loop from lab to math model to the outside world. It is a data acquisition, signal analysis, and waveform creation tool, all in an easy-to-use Microsoft Windows®-based program.

Waveforms can be acquired or created many different ways. Draw them, build them with the library, input math formulas, share data from programs like Excel®, or even get a real signal from a digitizing storage oscilloscope.

WaveForm DSP also has powerful math functions for combining, concatenating and

manipulating signals, with options for signal filtering and much more. Accuracy is assured because calculations are done in double precision (64 bit) math.

The signals you create can be used to drive an arbitrary function generator capable of reproducing any imaginable waveform. Or they can be output to printers, plotters, or saved as files for other applications.

Multiple windows can be open at once, and they can all be interactive. Imagine being able to change a waveform in the frequency domain and see

the results in a time domain plot on the same screen — with just the click of a mouse. Or change a signal going to a test and see a graphic display of the analyzed results.

If you haven't been comfortable with digital signal processing before, you will be now. And if you never thought of using arbitrary generators before, get ready for a whole new spectrum of possibilities.

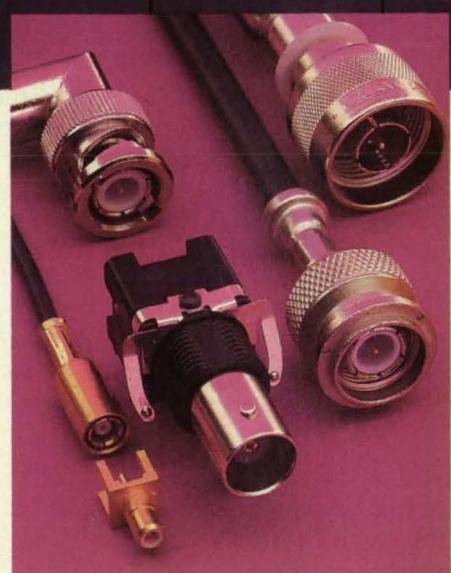
To try WaveForm DSP, call 1-800-223-9885.

Broaden your RF horizons.

S_{11}	SWR
REF	1.0



THIS IS AMP TODAY.



RF performance, DC to 50 GHz.



START 0.0000GHz
STOP 50.0000GHz

No matter what range you're working, your work goes better and faster with connectors engineered for the right balance of properties. AMP has the coax connectors you need for top performance, consistent electrical characteristics, and maximum manufacturability.

Select from a line that spans the spectrum—DC to 50 GHz—in a variety of 50 or 75 ohm versions. Our selection delivers the advanced

design and controlled properties you need, with commercial versions that exhibit Mil-equivalent performance. Our fully Mil-qualified versions offer productivity gains, as well, including our proven crimp/seal technology.

We support the broadest selection of RF connectors available with the broadest range of mounting options as well: from cable to bulkhead, panel to board—and now including

custom and semi-custom high-speed coax and transmission cable assemblies.

We'd like to extend all that support to you. For literature or the name of your nearest AMP Distributor, call the AMP Product Information Center at 1-800-522-6752 (fax 717-986-7575). In Canada call 416-475-6222. AMP Incorporated, Harrisburg, PA 17105-3608.

AMP



Physical Sciences

Hardware, Techniques, and Processes

- | | | |
|--|---|---|
| <p>32 Noncontact Measurement of Critical Current in Superconductor
34 Acoustic Device Would Measure Density of Gas</p> | <p>34 Measuring Thermal Diffusivity of a High-T_c Superconductor
38 Gel-Filled Holders for Ultrasonic Transducers
40 Digital Correlation in Laser-Speckle Velocimetry</p> | <p>41 Joule-Thomson Cooler Produces Nearly Constant Temperature
42 Rhenium-Foil Witness Cylinders
42 Orifices for Fuel-Film Cooling of Combustion Chamber</p> |
| Computer Programs
52 Eleven-Species Thermochemical Model of Air
52 Analyzing Satellite Images of the Ocean | | |

Noncontact Measurement of Critical Current in Superconductor

Critical current is measured indirectly via the flux-compression technique.

NASA's Jet Propulsion Laboratory, Pasadena, California

A method for determining the critical current density in a superconductive material as a function of magnetic-flux density is based on the magnetic-flux-compression technique. This method does not involve any electrical contact with the superconductor. Therefore, it does not cause the resistive heating and the consequent premature loss of superconductivity that occur in the relatively crude method of measuring current directly by attaching ordinary resistive leads to the superconductor. The present method also differs from an older noncontact magnetization method that does not always yield accurate information about the critical-current density.

The magnetic-flux-compression technique involves two steps. In the first step, one traps a magnetic field in the hole of a hollow circular cylindrical or other toroidal specimen of superconductor. This can be done, for example, by cooling the specimen below its superconducting-transition temperature while applying a magnetic field from, say, an electromagnet. When the electromagnet is turned off, the superconducted current maintains the magnetic field. In the second step, one inserts a closely fitting solid rod specimen of the superconductor (which has also been cooled to the superconducting state) in the hole. Because of the tendency of a superconductive body to conserve flux, the magnetic flux becomes compressed into the gap between the outer surface of the rod and the inner surface of the cylinder.

For the purpose of this method, an axial groove of circular cross section is made in the outer surface of the rod specimen to accommodate a dc Hall-effect probe that measures the axial magnetic-flux density near the inner surface of the cylinder (see Figure 1). This measurement is taken before the rod specimen is inserted (initial flux density, B_i) and again when the rod specimen has been inserted (final flux density, B_f). To obtain a set of data to characterize the specimens, such pairs of measurements are taken at a number of different values of B_i .

The measurements show that the compression ratio B_f/B_i varies with B_i . The measurements of B_f , B_i , the dimensions of the specimens, and other pertinent data can be analyzed by use of equations for the partial penetration of magnetic flux into the superconductor. These equations are derived from the mathematical model $J_c(B) = J_{c1}(B_{c1}/B)^n$ for $B > B_{c1}$, where B_{c1} denotes the first critical magnetic-flux density, J_{c1} denotes the critical current density at the critical magnetic-flux density, $J_c(B)$ denotes the critical current density at an axial magnetic-flux density of B , and n is a fitting parameter. By suitable manipulation of the equations and of the data, one can determine both n (Figure 2, top) and $J_c(B)$ (Figure 2, bottom).

This work was done by Ulf E. Israelsson and Donald M. Strayer of Caltech for NASA's Jet Propulsion Laboratory. For further information, Circle 119 on the TSP

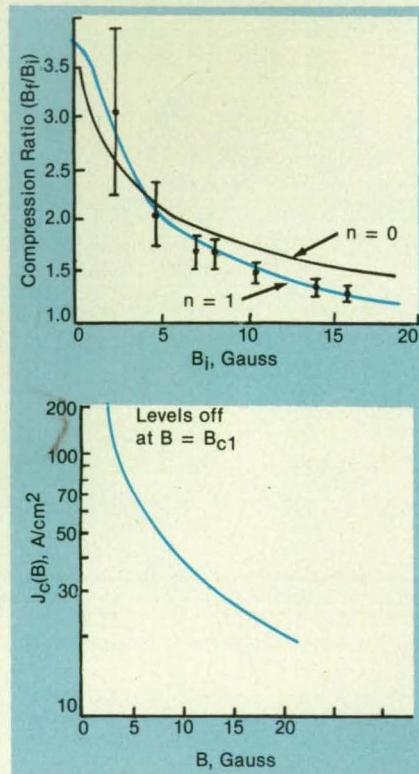


Figure 2. The **Compression Ratio** as a function of the initial magnetic field (upper plot) appears to fit the mathematical model with $n = 1$. The critical current density decreases with the magnetic field according to the model (lower plot). These data were obtained with specimens of sintered $\text{YBa}_2\text{Cu}_3\text{O}_7$, a high-temperature superconductor.

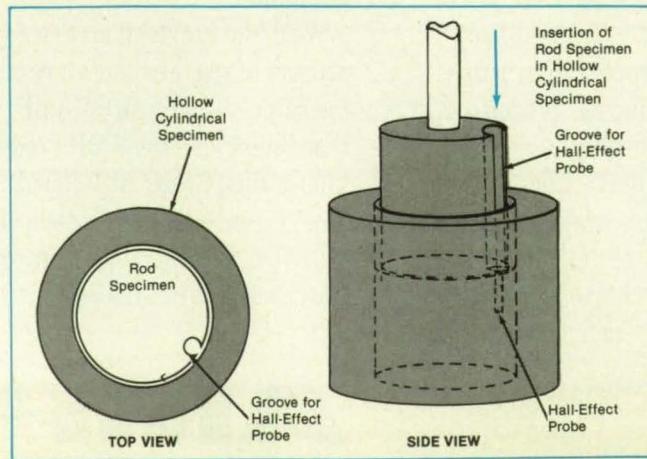


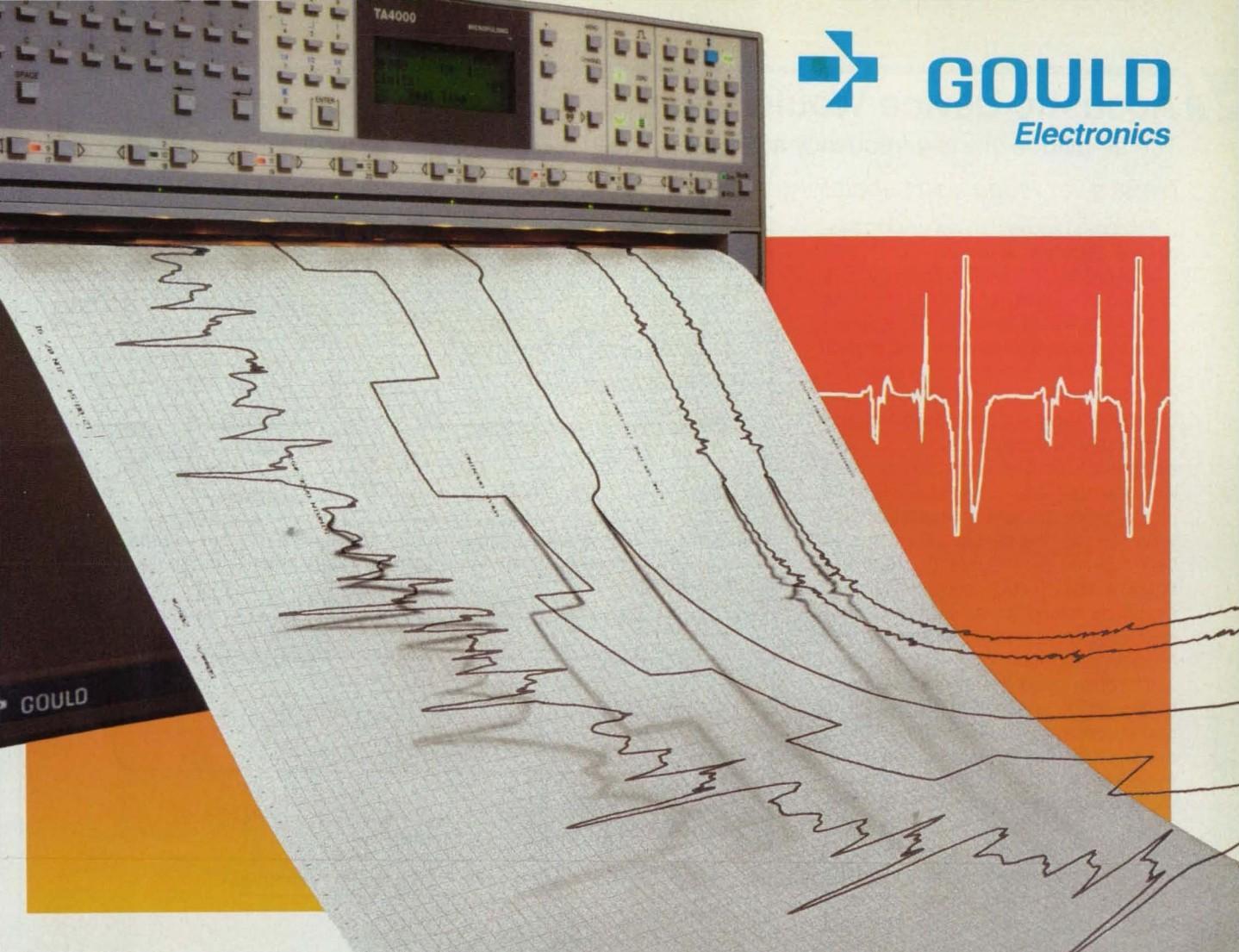
Figure 1. Magnetic Flux is Compressed into the gap between the superconductive hollow cylinder and the superconductive rod when the rod is inserted in the hole in the cylinder. The Hall-effect probe measures the flux density before and after compression.

Request Card.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

Edward Ansell
Director of Patents and Licensing
Mail Stop 305-6
California Institute of Technology
1201 East California Boulevard
Pasadena, CA 91125

Refer to NPO-18255, volume and number of this NASA Tech Briefs issue, and the page number.



The truth comes out.

When we say the Gould TA4000 has all the features you need to get the most accurate trace available, nothing could be closer to the truth.

First, Gould signal conditioners. Not only do we offer the industry's widest selection, but also the most accurate. So no matter what your application, you always have the right answer.

Second, the dedicated controls. Features like auto-setup and simple trace positioning make start-ups a breeze and minimize operator errors.

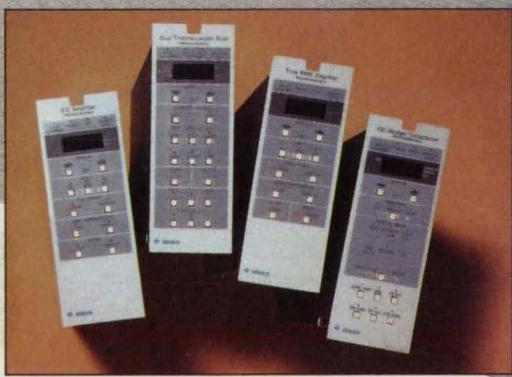
Then, its 15" printhead records 8 to 24 channels in

either separate or overlapping modes, with no gap in the center.

And finally, our exclusive Micropulsing® circuitry maintains brilliant contrast at all chart speeds and every signal frequency.

All this, backed by the largest sales and support organization in the recorder industry.

Call Gould today at 1-216-328-7000 or for immediate response fill out the coupon and FAX it to us today. And we'll give it to you straight.



----- **NTB 1/92**

Please Rush me a TA4000 brochure
 Have a Gould Sales Representative call

Name: _____

Title: _____

Company: _____

Street: _____

City: _____ State: _____ Zip: _____

Telephone: _____

Send to: Gould Inc., Test and Measurement Group, 8333 Rockside Road, Valley View, Ohio 44125. Fax: (216) 328-7400.



Acoustic Device Would Measure Density of Gas

The amplitude of a low-frequency acoustic signal indicates density.

NASA's Jet Propulsion Laboratory, Pasadena, California

A proposed acoustic sensor would measure the density of a flowing gas or mixture of gases. The sensor could be constructed in a variety of configurations for use in monitoring industrial processes.

In its basic configuration, the sensor would comprise a narrow tube closed at one end and open at the other, a sound transmitter located in the closed end, and a microphone located part of the way along the tube. The entire sensor, or at least the open end of the tube, would be placed inside the pipe or vessel that contains the gas, the density of which is to be measured (see Figure 1). The transducer would produce constant-velocity-amplitude sound waves at a frequency lower than the fundamental resonant frequency of the tube.

The open end of the sensor tube would be located in a space large enough to make the sound-pressure amplitude at the open end of the tube be zero. That is, for the purpose of mathematical analysis of the acoustic waves in the tube, the free-space boundary condition would be satisfied. The analysis shows, among other things, that under the free-space boundary condition, and provided that the length of the tube was a small fraction of the acoustical wavelength, the density of the gas in the tube would be approximately proportional to the sound-pressure amplitude at the location of the microphone and inversely proportional to the frequency.

If necessary, the acoustic signal could be extracted from the background noise in the microphone signal by use of a narrow-band filter. Alternatively a closed-tube version of the sensor (see Figure 2) could be used where too much noise would be picked up through the open end. Where there was insufficient space to satisfy the free-space boundary condition at one end of the tube, two sound transducers would be mounted at opposite ends of the tube and driven in opposite phase. This scheme would make the sound pressures add to zero at the midpoint of the tube, thereby simulating the free-space boundary condition.

When the sensor tube was mounted partially or entirely external to the main pipe or vessel, one or more bleed holes

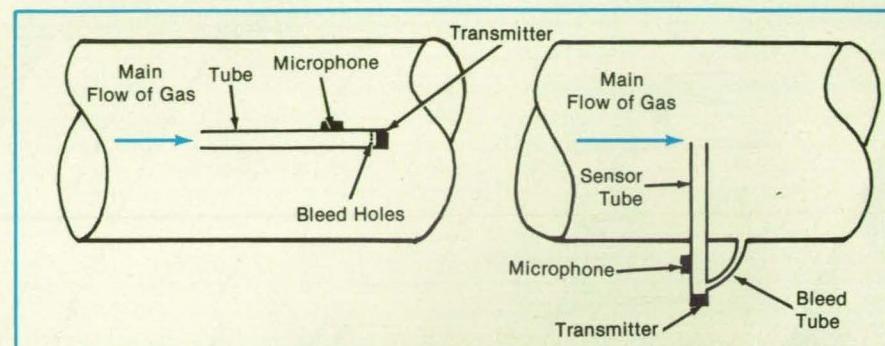


Figure 1. The Sensor Tube could be placed inside or partly outside the vessel containing the gas to be sampled. Many configurations other than the two shown here could be used.

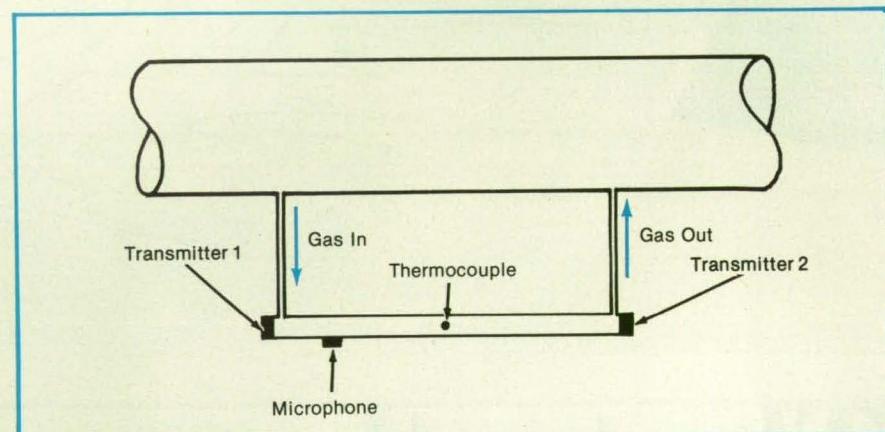


Figure 2. A Closed-Tube Version of the gas-density sensor would include a transmitter at each end of the tube.

of small cross section could be used to keep the pressure in the sensor tube the same as in the main pipe or vessel. Such an arrangement could also provide thermal isolation to protect the transducers and microphone from high process temperatures, but the measurement of density would then have to be corrected for the difference between the process and measurement temperatures.

A slight nonlinearity in the density as a function of sound-pressure amplitude could give rise to small errors (typically less than 1 percent) in the density measurements. These errors can be essentially eliminated by taking account of the dependence of the speed of sound upon temperature and accordingly adjusting the frequency of the sound so that the length

of the tube remains a constant fraction of a wavelength. The required frequency, f , for a gas at absolute temperature T is given by $f = f_0(T/T_0)^{1/2}$, where f_0 and T_0 denote the frequency and absolute temperature, respectively, at which the sensor would be calibrated.

This work was done by Parthasarathy Shakkottai, Eug Y. Kwack, and Lloyd H. Back of Caltech for NASA's Jet Propulsion Laboratory. For further information, Circle 4 on the TSP Request Card.

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, NASA Resident Office-JPL [see page 14]. Refer to NPO-18155.

Measuring Thermal Diffusivity of a High- T_c Superconductor

Thermal diffusivity is deduced from propagation of an oscillatory temperature wave.

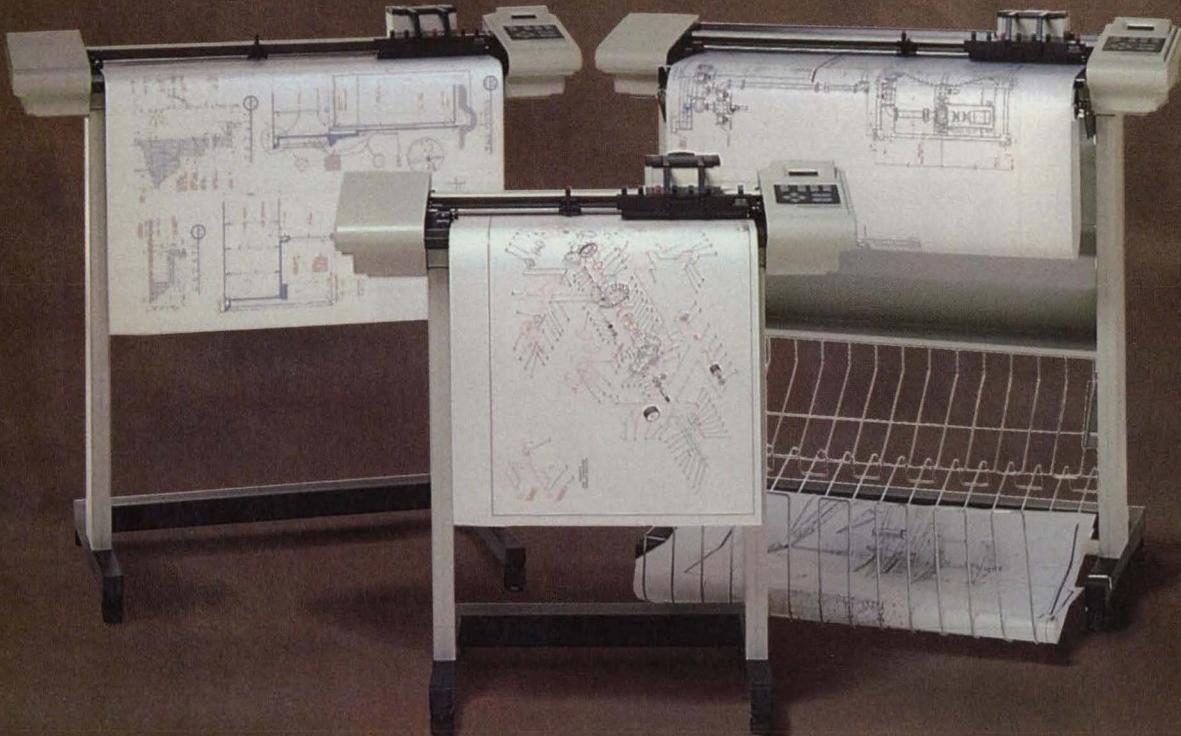
Goddard Space Flight Center, Greenbelt, Maryland

A technique for measuring the thermal diffusivity of a superconductor of high

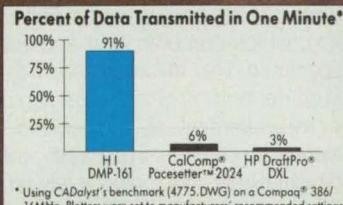
critical temperature (high T_c) is based on Angstrom's temperature-wave method. In

Angstrom's method, the thermal diffusivity of a material is deduced from measure-

Our DMP™-160 Series Does the Work of Four Plotters, a Scanner and a Night Shift.



Never before has one family of plotters done so much, so fast, and so well. Our D- and E-size plotters are the only ones that include the new, highly-compact HP-GL/2 plot language and 512K standard memory. That's the equivalent of 2 MB on other plotters. And they're the only ones that can be expanded to 4 MB. So instead of tying up you and your computer during long or multiple plots, our new plotters



release your equipment 15 to 30 times faster than the competition.

Increased AutoCAD® Productivity.

These new plotters arrive AutoCAD ready with ADI® drivers which allow you to immediately harness the full productivity features of the DMP-160 Series.

Set-It-and-Forget-It Unattended Plotting. Our DMP-162R E-size plotter comes with 1MB of memory and an automatic rollfeed and cutting system—ideal for network, multi-user or heavy plotting requirements. This workhorse does it all: Configures your plotter directly from your PC or Macintosh® with our Hot-To-Plot™ programs. Stores up to four different user configurations. Uses a pen grouping feature for up to eight times the pen life. And cuts and gathers plots in a catch-basket for immediate access. Just load a 150' roll of D- or E-size

paper, push a few buttons and go back to work. Or go home.

Turn Your Plotter Into a Scanner.

Only Houston Instrument offers the optional SCAN-CAD™ accessory and software that allows any DMP-160 Series plotter to double as an affordable, large format scanner.



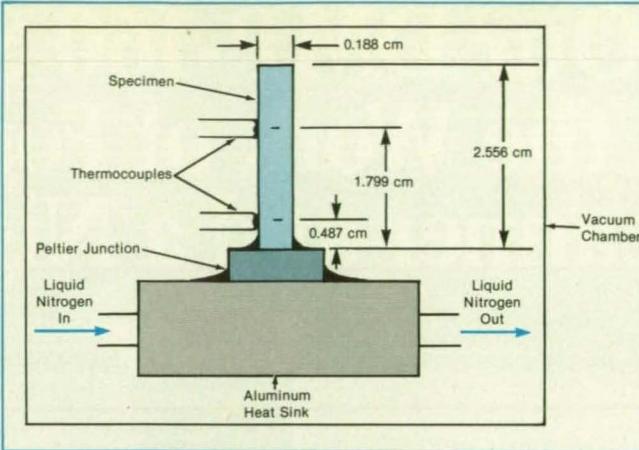
Every Decision Should Be This Easy™. See the new DMP-160 Series today. And find out what it's like to go home early at night. For information, or the name of your local dealer, contact Houston Instrument today at 1-800-444-3425.

HOUSTON INSTRUMENT.®
A Summagraphics Company

Circle Reader Action No. 550

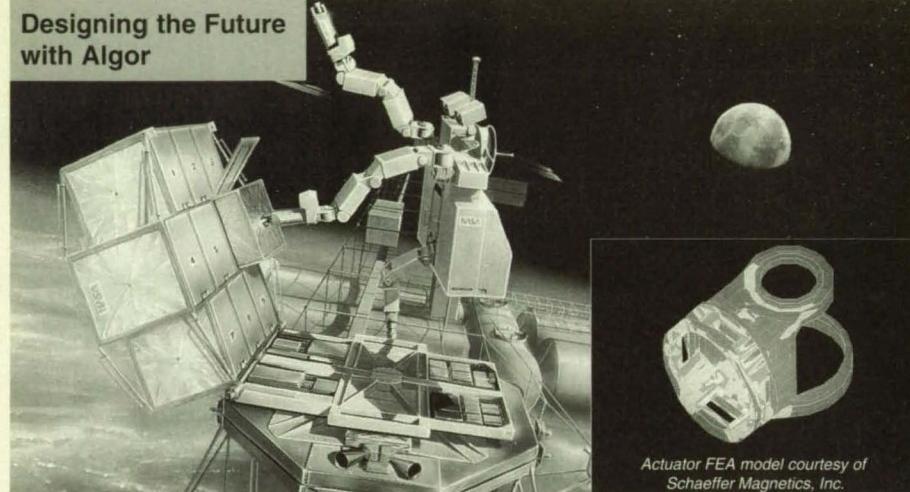
ments of the propagation of a temperature wave along a rod specimen of the material. The temperature wave could be a steady-state oscillation or a transient; in this case, a steady-state sinusoidal oscillation is chosen.

The specimen is mounted on a Peltier junction, which, in turn, is mounted on an aluminum heat sink (see figure). Two thermocouples are attached to the specimen. Liquid nitrogen flowing through the aluminum block cools the block, junction, and specimen to a specified steady initial temperature. The entire assembly is partially thermally insulated from the environment by mounting it in a vacuum: this enables



The Peltier Junction Generates Temperature Oscillations, which propagate with attenuation up the specimen. The thermal diffusivity of the specimen is calculated from the distance between thermocouples and the amplitudes and phases of the oscillatory components of the thermocouple readings.

Designing the Future with Algor



Actuator FEA model courtesy of Schaeffer Magnetics, Inc.

"Algor's FEA Design System has excellent processors, powerful graphics and accuracy at a price that has no match on the market" **Stefan B. Delin, Ph.D., Sr. Analytical Engineer, Schaeffer Magnetics, Inc., Chatsworth, CA.**

When Schaeffer Magnetics, a company with 24 years of spaceflight component design experience, was asked to provide actuators for NASA's Flight Telerobotic Servicer (FTS), they turned to Algor engineering software to optimize their design.

The FTS is designed to perform a variety of tasks in space, including the assembly and maintenance of spacecraft. The actuators are the "joints" for the arms and legs of the FTS. There is no room for compromise in the design of such critical components for this vital system. That's why Schaeffer Magnetics chose Algor.

Algor engineering software is the choice of more than 5,000 engineers worldwide because it's more powerful, easier to use, better supported and less costly than competitive systems.

High level service at low cost is a key component of Algor's success. Every Algor customer gets a full year of technical support and free upgrades, a monthly newsletter and access to a low cost, long term maintenance program. Plus, Algor performs training classes and customized, on-site seminars almost every day.

Schaeffer Magnetics is building the future with Algor. You can, too. Phone or fax today for our comprehensive technical literature package.

Algor FEA and Design Packages for IBM Compatible 286, 386 and 486 Computers and Sun SPARCstations

Linear Stress	Buckling
Electrostatic	Frequency Response
Nonlinear Stress	Composite Elements
Random Vibration	Nonlinear Gap/Cable
Vibration & Mode Shape Analysis	Steady-State & Transient Heat Transfer
Parametric and Variational Modeling	Steady-State & Transient Fluid-Flow
Computer Aided Design	Modeling & Design Visualization
Modal Analysis with Load Stiffening	Beam Design Editor

♦ **ALGOR**®

Algor, Inc. • 260 Alpha Dr. Pittsburgh, PA 15238
Phone: 412-967-2700 • Fax: 412-967-2781
In California: 714-755-3207

GSA Contract # GS 00 K 89 AGS 6270 PS01

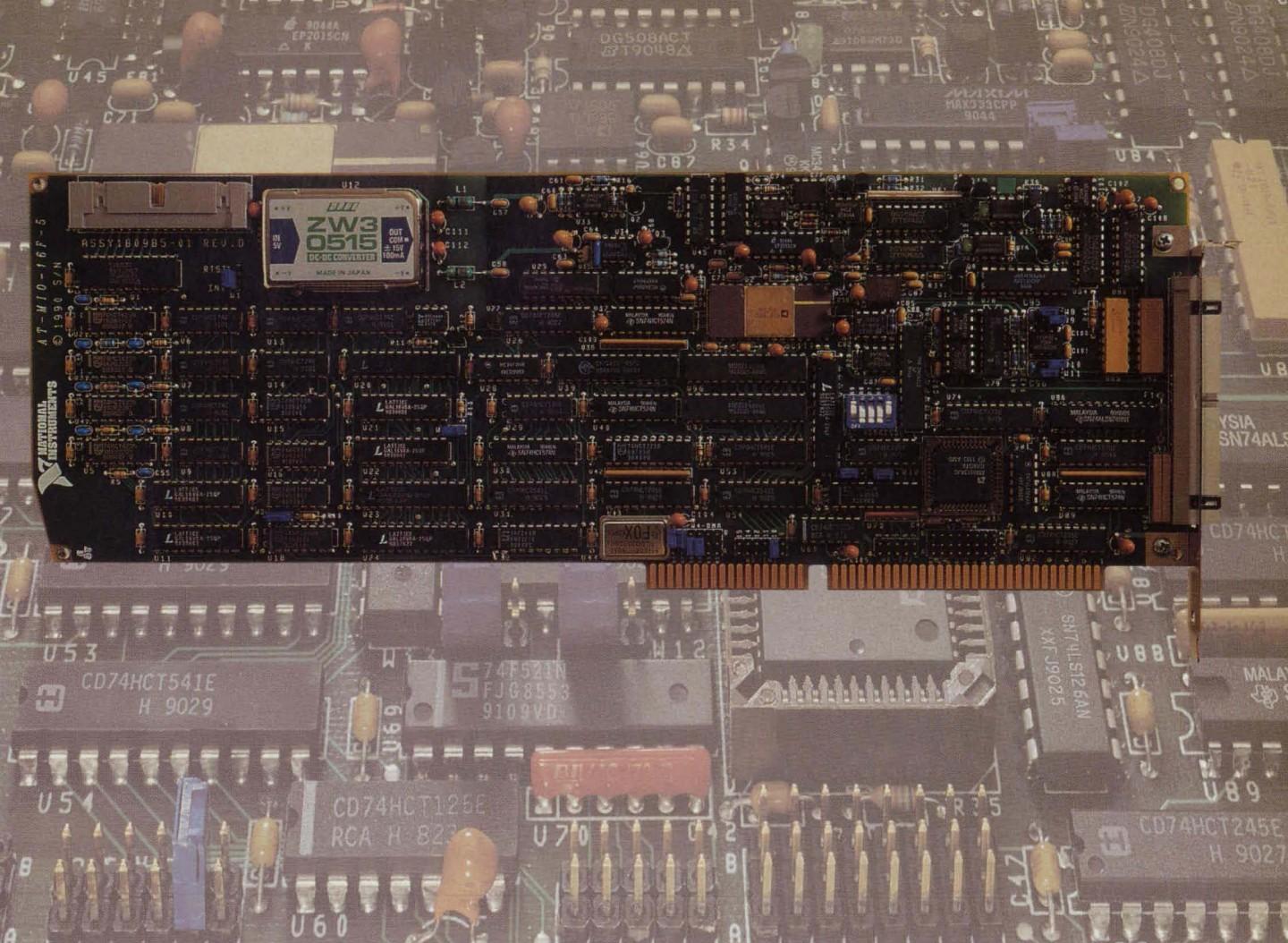
Sun and SPARCstation are Trademarks of Sun Microsystems.

measurements at initial temperatures from 150 to 300 K. Future mounting in a cryostat will enable measurements at initial temperatures from 10 to 300 K.

The sinusoidal temperature wave is introduced into the specimen at its lower end by exciting the Peltier junction with a sinusoidal voltage. The frequency of oscillation is typically chosen to be some value between 0.01 and 0.05 Hz. The voltage across each thermocouple is sampled once per second, yielding between 20 and 100 measurements per cycle at each thermocouple location. These samples are processed to obtain the amplitudes and phases of the temperature oscillations at each thermocouple. The thermal diffusivity can then be calculated as a function of the ratio between the amplitudes, the difference between the phases, and the distance between the thermocouples. This oscillatory-temperature-wave technique offers several advantages:

- It eliminates most of the lateral thermal losses and thermal interfaces typical of other longitudinal-heat-flow methods. This feature is necessary to obtain accurate results from specimens of low thermal conductivity.
- It is more suitable for use on brittle materials because no pressure is applied to the specimens. In contrast, other longitudinal-heat-flow methods require the application of pressures, which tend to fracture the specimens.
- The use of an oscillatory temperature wave is made possible by the Peltier junction, which can both heat and cool the specimen. This, in turn, means that there is no net heating of the specimen during a measurement at a specified initial steady temperature. In contrast, other longitudinal-heat-flow methods rely on resistive or other "one-way" heating, causing the position-averaged temperature of the specimen to increase in time and thereby degrading the accuracy of the results.

This work was done by Charles E. Powers, Gloria Oh, and Henning Leidecker of Goddard Space Flight Center. For further information, Circle 155 on the TSP Request Card.
GSC-13392



EXCELLENCE

Setting the New Standard in PC Data Acquisition

It takes a serious commitment to quality to deliver data acquisition boards that reliably meet the most demanding specifications. The National Instruments AT-MIO-16F-5 board creates a new standard in excellence with features not found on typical data acquisition boards.

These features include:

- 200 ksamples/sec sampling rate
 - Software-configurable analog input and gain
 - Optimum noise control
 - True self-calibration
 - Dither generator for extended resolution
 - RTSI® bus for multi-board synchronization
 - Custom instrumentation amplifier
 - Microsoft Windows and DOS driver software

EISA-A2000



AT-MIO-16F



AT-MIO-16D



Lab-PC



PC-LPM-1

Software for programming the AT-MIO-16F-5 ranges from drivers for Microsoft Windows and DOS to LabWindows® application software. The quality, innovation, and performance of the AT-MIO-16F-5 sets the new standard in PC data acquisition. For more information on the AT-MIO-16F-5,

	<i>ANALOG OUTPUT</i>	<i>SOFTWARE</i>
Channels		
Resolution (bits)		
Digital I/O Channels		
Counter/Timers		
LabWindows		
LabDriver for DOS		
Measure		
VisionScope		
Third Party		

Circle Reader Action No. 691

* SE – Single-Ended, DI – Differential, SS – Simultaneous Sampling

+ 8 Channels In, 8 Channels Out

AUSTRALIA (03) 879 9422 - DENMARK (45) 76 73 22 - FRANCE (1) 48 65 33 70 - GERMANY (089) 714 5093 - ITALY (02) 4830 1892

JAPAN (03) 3788 1921 - NETHERLANDS (01720) 45761 - NORWAY (03) 846 866 - SPAIN (908) 604 304 - SWITZERLAND (056) 45 58 80 - U.K. (0635) 523 545

Product names listed are trademarks of their respective manufacturers. Company names listed are trademarks or trade names of their respective companies. ©Copyright 1991 National Instruments Corporation. All rights reserved.



Gel-Filled Holders for Ultrasonic Transducers

A transducer is cast in place at the desired angle and position on an object or patient.

Langley Research Center, Hampton, Virginia

A need exists in medicine and industry for the ability to use ultrasound to look into materials at known fixed angles to the surfaces while maintaining good acoustical contact and low attenuation. In medical applications, current equipment for doing this includes motor-driven or phased-array sector scanners and various types of fixed-head probes. For industrial use there are variations of the above, with the addition of poly(methyl methacrylate) angle blocks, and squirter systems. In both realms, water baths are used extensively. None of these devices is well suited for use on an ambulatory patient or on a large, irregular, object.

In a new technique, an ultrasonic transducer is embedded in a rubbery, castable, low-loss gel to enable the transducer to "look" into the surface of a test object or human body at any desired angle (see figure). The gel is composed of a solution of water and ethylene glycol in a collagen matrix. The water, which can be as much as 80 percent of the mixture, is an excellent conductor of ultrasound. The ethylene glycol serves to reduce the rate of evaporation, thereby extending the usable

lifespan. The collagen enables the gel to hold its shape.

The gel can be made up quickly and inexpensively. Because it is quite fluid when fresh, it can be catalyzed and poured into a mold easily. Once the material has been catalyzed with formaldehyde, it sets up into a solid within a few minutes. The resulting material is not mechanically tough, but it tolerates high temperatures and does not dry. Its acoustic impedance is close to that of water or human tissue.

If a reusable assembly is required, a transducer can be secured at the desired angle to the back wall of an enclosure, which can then be filled with the gel. Because of the nondrying characteristic of the material, sealing is not critical. The face of the transducer housing can be fitted with a thin plastic skin to provide resistance to abrasion if a large number of uses is contemplated. For the short term, or to provide better coupling, the skin can be eliminated.

To achieve the best possible coupling, or in the case of an irregular surface, the gel can be cast right onto the surface. The enclosure would then take the form of a dam, to be filled from the back. This ar-

rangement would simply be peeled off the surface and off the transducer and discarded after use. Because the material is somewhat flexible, it is possible to vary the angle of the transducer slightly.

The technique described here can provide the total contact of a water bath but can be used on bodies or objects that are too large for water baths, even if they are moving. The technique can provide the look angles of a poly(methyl methacrylate) angle block with the potential of reduced acoustic impedance and refraction. It can be custom-tailored to the task at hand, and the gel is sufficiently inexpensive so that it can be discarded upon completion. It is easy to couple ultrasound in and out of the gel, minimizing the losses and artifacts of other types of standoffs employed in ultrasonic testing.

This work was done by John A. Companion of Planning Research Corp. for Langley Research Center. For further information, Circle 19 on the TSP Request Card.

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Langley Research Center [see page 14]. Refer to LAR-14027.

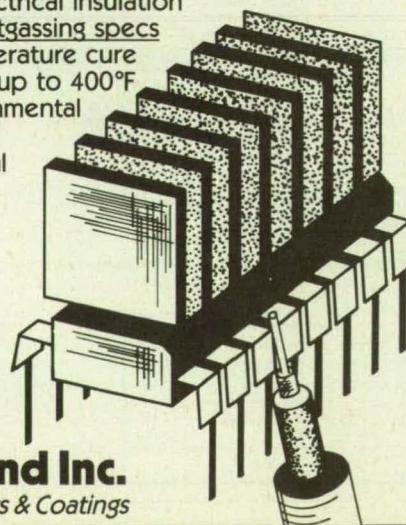
THERMALLY CONDUCTIVE EPOXY

NEW

MASTER BOND EP21TCHT-1 EPOXY SYSTEM

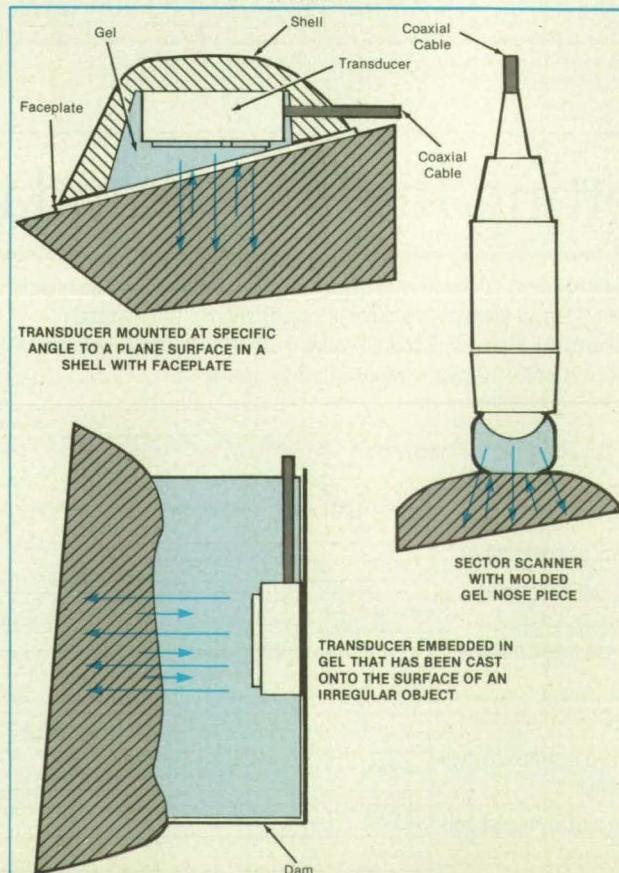
- Outstanding electrical insulation
- Passes NASA outgassing specs
- Fast room temperature cure
- Heat resistance up to 400°F
- Superior environmental protection
- High dimensional stability
- Convenient packaging

For information, call or write:
Master Bond Inc.,
154 Hobart St.
Hackensack, NJ 07601
201-343-8983



Master Bond Inc.
Adhesives, Sealants & Coatings

Circle Reader Action No. 619



The Nondrying, Low-Loss Gel serves as a versatile transmission medium for an ultrasonic transducer.

How to spend less time thumbing through books and more time thumbing through results.

New Mathcad 3.0

New Mathcad 3.0 crunches, graphs, updates, and documents your work in real math notation. Automatically.

New symbolic capabilities are available with a simple menu pick.

It's the fast, efficient, comprehensive way to do technical calculations.

Move those reference texts off your desk. Put that calculator back in your pocket. And save that cryptic spreadsheet for your budgets and bookkeeping.

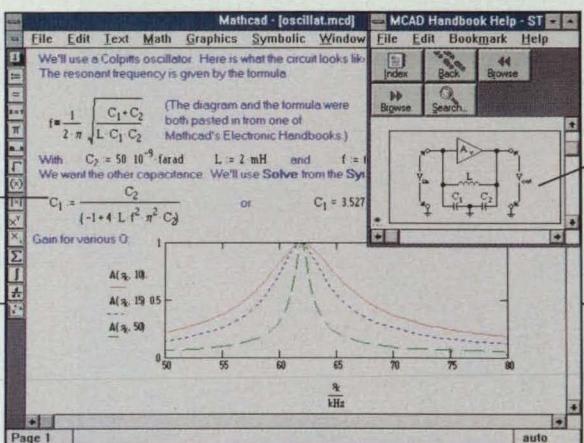
It's time to get problems out of the way and make room for answers. With new Mathcad 3.0, the major new upgrade to the world's best-selling math software.

It's the all-in-one solution with a singular purpose: to put results in your hands as quickly and thoroughly as possible.

New Mathcad is a workhorse that handles everything from simple sums to matrix manipulation. Effortlessly, naturally.

Simply type your calculations into the live document, just like you'd write them on a scratch pad. And let Mathcad do the work for you. It performs the calculations. Graphs in 2-D or 3-D. Automatically updates results each time you change a variable. And prints out presentation-quality documents, complete with equations in real math notation, even scanned-in graphics.

Newly upgraded Mathcad 3.0 now has Electronic Handbooks for instant access to



New Windows 3.0 interface makes calculation fast and effortless.

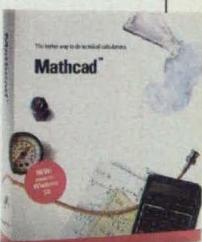
New Electronic Handbooks give instant access to hundreds of standard formulas. Just click 'n' paste.

Civil and Chemical Engineering, Statistics, Advanced Math, and Numerical Methods

- Differentials, cubic splines, FFTs, matrices and more
- Enhanced 2-D and 3-D graphics
- Improved presentation-quality documentation
- PC DOS, Macintosh®, and Unix® versions also available

For a FREE Mathcad demo disk, or upgrade information, call 1-800-MATHCAD (or 617-577-1017, Fax 617-577-8829). Or see your software dealer.

Available for IBM® compatibles, Macintosh computers, and UNIX workstations.



TM and ® signify manufacturer's trademark or registered trademark respectively.

1-800-MATHCAD

The answer is Mathcad®

MathSoft, Inc.
201 Broadway, Cambridge, MA 02139



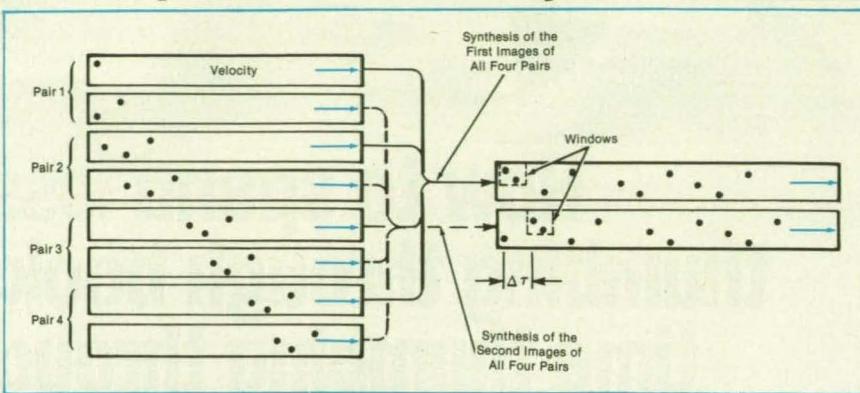
Mathcad 2.5
3-14-89 issue.
Best of '88
Best of '87

Digital Correlation in Laser-Speckle Velocimetry

A periodic recording helps to eliminate spurious results.

Marshall Space Flight Center,
Alabama

An improved digital-correlation process extracts the velocity field of a two-dimensional flow from laser-speckle images of seed particles distributed sparsely in the flow. Some prior methods of laser-speckle velocimetry have involved various combinations of optical and electronic tech-



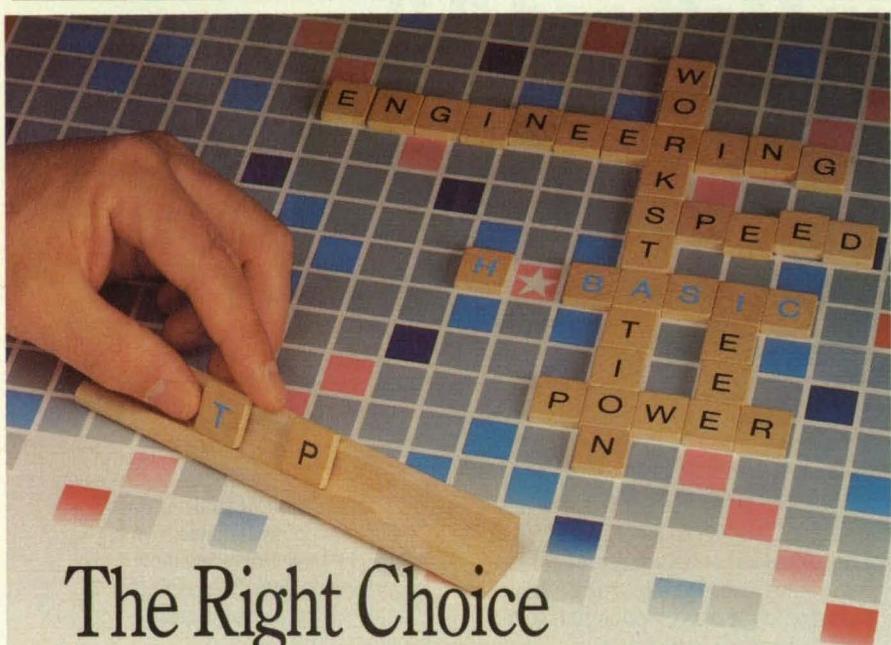
Laser-Speckle Images of seed particles are recorded in pairs, with an equal interval within each pair and unequal intervals between successive pairs. A synthesis of the first images of all the pairs is then correlated with a synthesis of the second images to obtain the velocity field.

niques, have tended to be slow, and have required considerable intervention by analysts. A more recent method that led to the present improved method involved the semiautomated digital correlation, on a desktop computer, of speckle images recorded at equal intervals of time. This predecessor method was relatively fast because, unlike methods that included optical techniques, it did not require mechanical scanning of images. The new method, which involves the digital correlation of images recorded at unequal intervals, can be completely automated and, therefore, has the potential to be the fastest yet.

Digital correlation is a method for the recognition of patterns, in which a small portion of a first image is located and identified in a small portion (called the "window") of a second image, which could be distorted and displaced with respect to the first image. In this case, the images are the laser-speckle patterns taken at two slightly different times, and the second pattern is slightly distorted and translated with respect to the first one because of the flow. The resemblance between the second and first images is measured via a coefficient of correlation:

$$\rho(m,n) = \frac{\sum_x \sum_y [f(x,y) - \langle f \rangle]}{\sqrt{\{ \sum_x \sum_y [f(x,y) - \langle f \rangle]^2 \} \cdot \{ \sum_x \sum_y [w(x-m,y-n) - \langle w \rangle]^2 \}}}$$

where $\rho(m,n)$ is the coefficient of correlation for a window centered at coordinates m,n in the second image, $f(x,y)$ is the intensity of the second image at point x,y within the window, $w(x-m, y-n)$ = the intensity of the first image at the corresponding point, $\langle f \rangle$ is the average intensity of the window portion of the second image, and $\langle w \rangle$ is the average intensity



The Right Choice Could Save You \$25,000.

HTBasic from TransEra will turn your PC into a scientific workstation at a fraction of the cost. A *real* alternative to a high-priced dedicated workstation, a PC with HTBasic gives you the capabilities you need for complex scientific/engineering applications, while retaining compatibility to run and share data with standard PC software.

The savings don't end with the workstation itself. With an HTBasic system, you can use industry-standard printers, graphic output devices, and networking systems. You get the flexibility you need to lay out the system you want without being tied to limited offerings from one supplier.

HTBasic is a state-of-the-art language which gives you a number of advanced

scientific/engineering features not found in other BASIC packages.

Features such as data acquisition and IEEE-488/RS-232 instrument control syntax, COMPLEX arithmetic, matrix mathematics, complete HP-style graphics, a comprehensive on-line help facility, and many more, add up to increased productivity for all levels of users.



The right choice for your next engineering workstation is a PC with HTBasic. Call or write us today for more information.

TransEra

Engineering Excellence for 15 Years™

3707 N. Canyon Road Provo, UT 84604
(801) 224-6550 Fax (801) 224-0355

of the corresponding part of the first image. The position m,n for which $\rho(m,n)$ is a maximum is the position at which the second image is considered to match the first image best.

In the basic approach to velocimetry via digital correlation, systematic matches of intensity samples are extracted from a sequence of digitized speckle patterns recorded at different times. Displacements between matched patterns are then divided by the increments of time between exposures to obtain a velocity field.

When the speckle images are record-

ed at equal intervals of time, periodicity and sparseness in the spatial patterns can give rise to false correlation peaks. To suppress the tendency toward false correlations, images can be enriched and partly randomized. The images are still recorded in pairs with the interval between the first and second images in each pair equal to the interval between the first and second images in every other pair. However, the pairs are recorded at unequal intervals (see figure). An enriched, randomized first image is synthesized by adding together the intensity patterns of the first images

of all the pairs. An enriched, randomized second image is synthesized similarly from the second images of all the pairs (see figure). Then the correlation is performed between the synthetic first and second images to obtain a velocity field more nearly free of errors.

This work was done by John A. Gilbert of the University of Alabama in Huntsville and Donald R. Mathys of Marquette University for Marshall Space Flight Center. For further information, Circle 114 on the TSP Request Card.

MFS-26122

Joule-Thomson Cooler Produces Nearly Constant Temperature

Variations in atmospheric pressure have little effect on temperature.

NASA's Jet Propulsion Laboratory, Pasadena, California

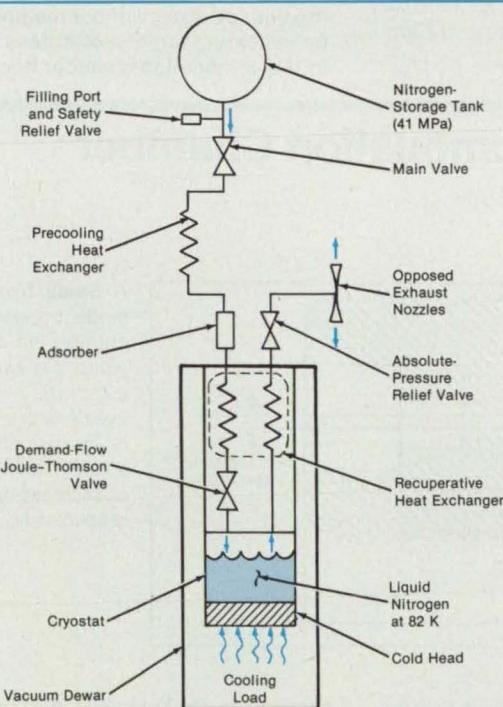
An improved Joule-Thomson cooler maintains a nearly constant temperature in its cold head, despite variations in atmospheric pressure. Coolers of this type could provide the stable low temperatures required for the operation of such devices as tunable diode lasers in laboratory and balloon-borne instruments that detect contaminants in the atmosphere.

The cooler (see figure) is of the "blow-down" type, in which the nitrogen working fluid is supplied as gas pressurized in a tank at ambient temperature. When the main valve is opened, gas at high pressure flows from the tank and is precooled by

the ambient atmosphere via an external heat exchanger. The gas then passes through an adsorber, which removes impurities, before entering the cryostat. In the cryostat, the gas is cooled further in a counterflow recuperative heat exchanger before expanding through the Joule-Thomson valve, which is essentially an orifice. The isenthalpic expansion in the Joule-Thomson valve causes a decrease in temperature and partial liquefaction of the nitrogen. The liquid nitrogen is vaporized by the combined heat load from the

laser or other devices to be cooled and from parasitic heat leaks.

The cold vapor returns through the recuperative heat exchanger and is exhausted to the atmosphere. The temperature of the liquid produced by the Joule-Thomson valve is the saturation temperature that corresponds to the exhaust pressure. To prevent fluctuations in atmospheric pressure from affecting the exhaust pressure and, thereby, the temperature of the liquid, the exhaust is passed through an absolute-pressure relief valve.



The **Absolute-Pressure Relief Valve** helps to stabilize the temperature of the cold head despite variations in atmospheric pressure. The feedback-controlled electrical heater provides additional stabilization. The demand-flow Joule-Thomson valve requires less nitrogen than does a fixed-orifice Joule-Thomson valve that provides the same amount of cooling.

Edmund Scientific



Free Reference Catalog For Your Technical Library

196 Pages, Over 8000 Products

Our new catalog describes one of the largest and most diversified lines in the nation of precision lenses, optics and optical instruments plus many hard-to-find scientific and technical products used in science, industry and by researchers.

TEL: 1-609-573-6250 FAX: 1-609-573-6295

- PRECISION OPTICS STOCK AND CUSTOM**
- Spherical
- Elliptical ■ Parabolic
- Front/Second Surface, Mirrors
- Optical Flats
- Gold Coated Mirrors
- Beam Splitters
- Laser Optics
- Simple Lenses
- Achromats ■ Prisms
- Fiber Optics
- Fresnel Lenses
- Magnifiers
- Polarizers
- Filters
- OPTICAL INSTRUMENTS**
- Microscopes
- Reticles
- Collimators
- Comparators
- Lasers



Edmund Scientific Co.
Dept. 12B1, N922 Edscorp Bldg., Barrington, NJ 08007

Circle Reader Action No. 461

Like many other blowdown Joule-Thomson coolers used in scientific, military, and industrial applications, this one includes a thermostatically self-regulating demand-flow mechanism that automatically throttles the Joule-Thomson orifice from its wide-open, high-flow-rate position during initial cooldown to a low-flow-rate position during steady operation. The demand-flow configuration reduces the consumption of gas by 65 percent below that of a fixed-orifice Joule-Thomson valve.

Low power (0 to 500 mW) is supplied to an electrical heater on the cold head in response to feedback from a temperature sensor on the cold head. This feature provides further stabilization and fine adjustment of the temperature. In conventional Joule-Thomson systems, temperatures in steady operation may fluctuate 1 to 2 K, with periodic fluctuations of about 5 K. In this system, temperature drift rates of less than 0.1 mK per minute have been measured.

This work was done by Steven Bard, Jiunn-Jeng Wu, and Curtis A. Trimble of Caltech for **NASA's Jet Propulsion Laboratory**. For further information, Circle 112 on the TSP Request Card.

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, NASA Resident Office-JPL [see page 14]. Refer to NPO-18184.

Rhenium-Foil Witness Cylinders

A simple device indicates an excess of oxidizer in combustion-chamber flow.

NASA's Jet Propulsion Laboratory, Pasadena, California

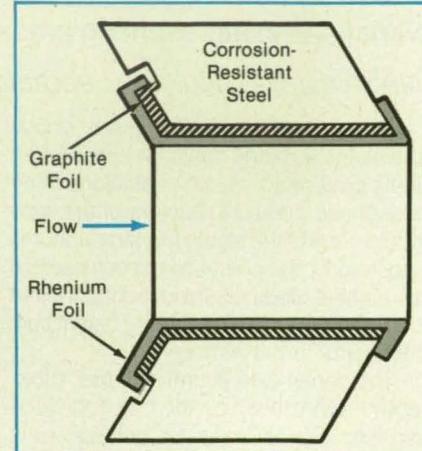
Cylinders of rhenium foil have been used to obtain qualitative indications of locations and amounts of excess oxidizer gas in the oxidizer-and-fuel mixture flowing from a bipropellant injector into the combustion chamber of a rocket engine. It is necessary to obtain these indications in design tests because excess oxidizer can damage the wall of the chamber. Rhenium witness foils might also be useful in detecting excess oxygen or other oxidizers at temperatures between 2,000 and 3,600 °F (about 1,100 and 2,000 °C) in the burner cores of advanced gas-turbine engines.

The rhenium foil, 0.003 in. (0.08 mm) thick, is mounted on a corrosion-resistant steel holder, insulated from the holder by a layer of graphite foil 0.015 in. (0.38 mm) thick (see figure). The inner surface of the

rhenium cylinder thus formed serves as a temporary replacement and witness cylinder for that portion of the wall of the combustion chamber in which damage by oxidation was observed previously.

Rhenium oxidizes easily at the combustion temperature but melts at the much higher temperature of 5,700 °F (about 3,100 °C). The amount of rhenium lost is therefore roughly proportional to the amount of oxidizer at the wall of the combustion chamber. A fresh rhenium witness cylinder is installed to evaluate the effect of each change in design upon oxidation of the wall.

This work was done by B. L. Knight of Aerojet TechSystems for NASA's Jet Propulsion Laboratory. For further information, Circle 103 on the TSP Request Card. NPO-18224



A Cylindrical Portion of the Wall of the combustion chamber is replaced with rhenium foil mounted on a holder. The rhenium oxidizes without melting, thereby indicating regions of excess oxidizer in the combustion-chamber flow.

Orifices for Fuel-Film Cooling of Combustion Chamber

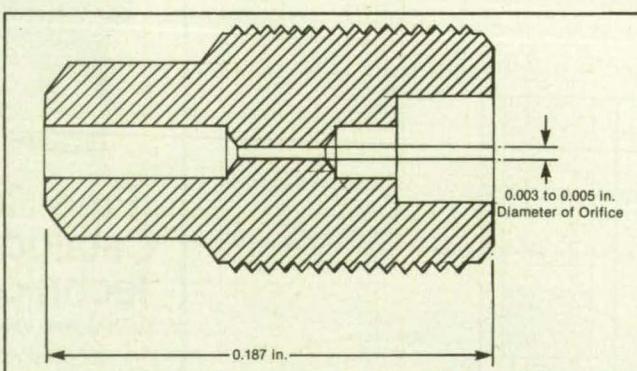
Injected fuel cools the wall and neutralizes excess oxidizer.

NASA's Jet Propulsion Laboratory, Pasadena, California

A boundary-layer film of fuel flows along the wall of the combustion chamber mentioned in the preceding article, "Rhenium-Foil Witness Cylinders" (NPO-18224), cooling the wall and neutralizing the excess of oxidizer in the vicinity of the wall. This boundary-layer cooling flow enters the chamber through 16 small, replaceable nozzles placed around the periphery of the fuel-and-oxidizer injector.

The boundary-layer cooling flow of fuel at each of the 16 locations can be adjusted, independently of the main injected flow of fuel and oxidizer, by selection of a nozzle that passes a larger or smaller flow. A larger flow at a given location would be selected, for example, if a rhenium-foil hot-fire test like the one described in the preceding article indicated an excess of oxidizer at that location.

Each nozzle (see figure) is a small setscrew. An orifice that has a diameter between 0.003 and 0.005 in. (0.08 and 0.13



A Small Nozzle is made by laser-machining an orifice along the axis of a setscrew. A similar nozzle with a larger or smaller orifice is selected to increase or decrease the flow, respectively.

mm) is laser-machined into the setscrew. A small cylindrical screen filter in a cavity upstream of the orifice prevents clogging of the orifice. To distribute the cooling flow more evenly around the circumference of the chamber, the jet of cooling fuel from each such nozzle is aimed at an angled splash plate in the resonator cavity of the

chamber to convert the jet to a fine, atomized spray.

This work was done by B. L. Knight of Aerojet TechSystems for NASA's Jet Propulsion Laboratory. For further information, Circle 105 on the TSP Request Card. NPO-18225

How do you connect these together?



With the SR630 Thermocouple Monitor. The complete \$1495 temperature solution.

Temperature monitoring can be a **big** pain. Different types of thermocouples. Remote locations. Time stamped data logging. Amplified outputs for analog recording and control. Additional voltage inputs. Independent alarms for each sensor. Interfaces to computers and printers. You need it all and you need it under budget.

Here's the answer. The SR630 Thermocouple Monitor from SRS. It interfaces 7 types of thermocouples, 16 independent channels of data and easily handles monitoring and logging functions as well as computer interfacing. And the easy to use front panel makes setup a snap.

The price? A painless \$1495. For more information about the SR630, call SRS at **(408) 744-9040**.

SR630 Thermocouple Monitor

- 16 input channels
 - 0.1 degree resolution
 - B, E, J, K, R, S, and T type thermocouples
 - °C, °K, °F, and mV dc readings
 - 2000 point non-volatile memory
 - 4 proportional analog outputs
 - Audible alarm
 - GPIB, RS232 and Printer interfaces
-



**STANFORD
RESEARCH
SYSTEMS**

1290 D Reamwood Avenue, Sunnyvale, CA 94089
TEL (408)744-9040 FAX 4087449049 TLX 706891 SRS UD

Circle number 8 on Reader Service Card

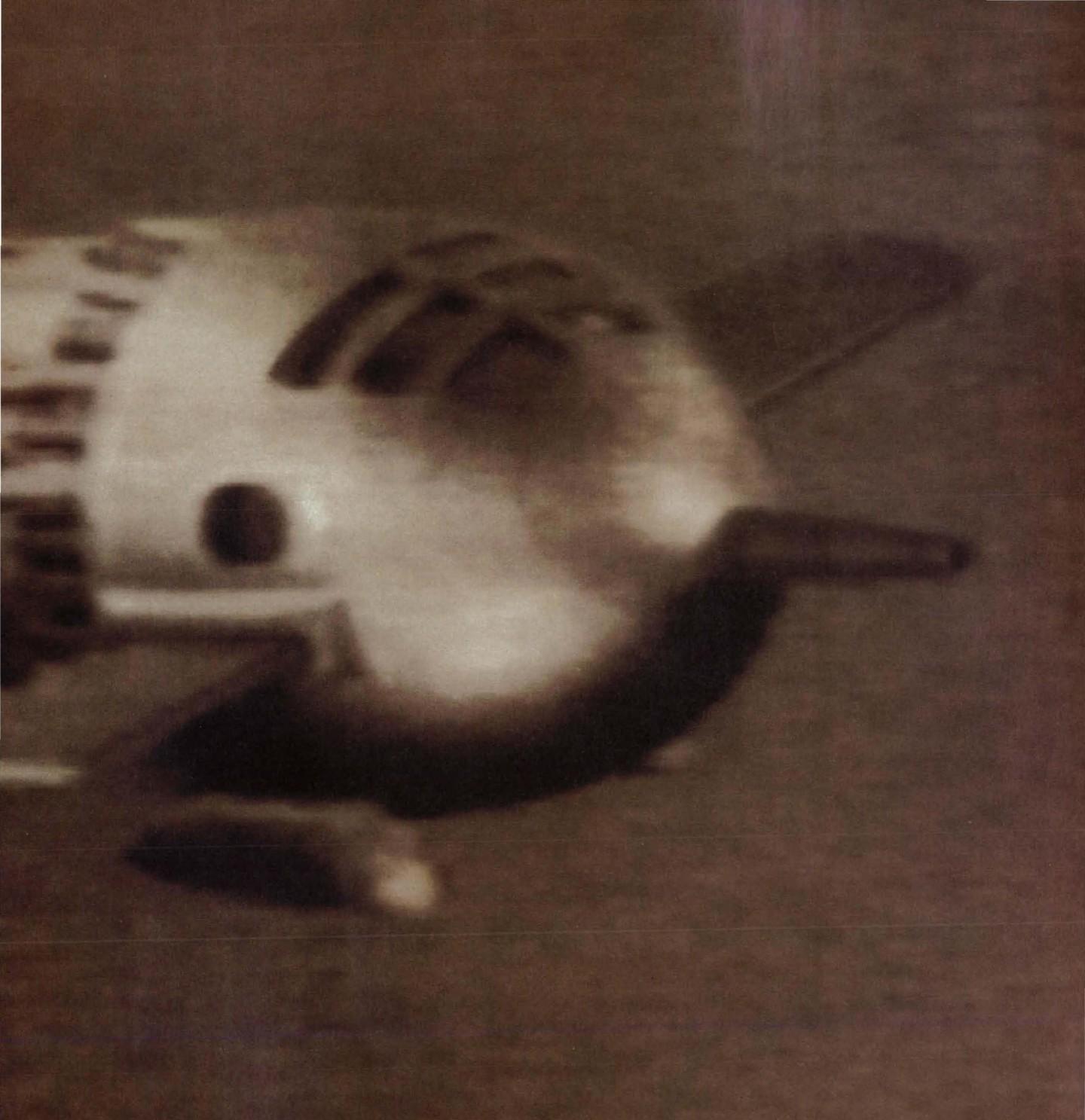


One space vehicle tha

It wasn't that long ago when the only space vehicles around were ones that landed on planets with names like Mongo. Then along came Garrett Fluid Systems Division. And space just hasn't been the same place since.

In fact, our involvement in fluid control systems, space valves, dynamic space power and specialized actuators spans the history of the space program itself. From Atlas, Thor, Titan and Saturn. To Mercury, Gemini, Apollo, LEM and Space Station Freedom.

As the world leader in fluid systems technology, we're generating the solutions to the challenges of new generations of launch vehicles, space platforms, as well as NASP-type applications.



got there without us.

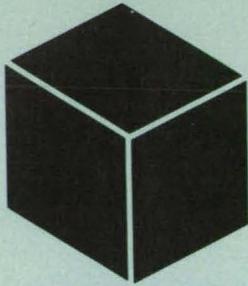
Our expertise includes a wide variety of systems. Thrust vector control, exhaust nozzle extension control, stability augmentation, fluid control, space power, propulsion management, separation and recovery. Plus complete facilities for testing and analysis.

As long as there are systems to be controlled, nozzles to be directed, rockets to be stabilized and power to be generated—more efficiently and with lower life cycle costs—space is where you'll find us.

Unless, of course, you contact us at **Garrett** Fluid Systems Division, 1300 West Warner Road, Tempe, AZ 85284. (602) 893-4420.

Circle Reader Action No. 415

 **Allied
Signal Aerospace**



Materials

Hardware, Techniques, and Processes

46 Determining the Degree of Graphitization in Carbon Composites

48 Ceramic-Fibrous-Insulation Thermal-Protection System

Determining the Degree of Graphitization in Carbon Composites

An effective solubility parameter is inferred from an infrared reflectance spectrum.

NASA's Jet Propulsion Laboratory, Pasadena, California

A method for determining the degree of graphitization of a carbon/carbon composite material combines an infrared spectral experimental technique with a thermodynamical theoretical model of solubility. By interrupting the manufacturing process at almost any time and applying the method, one can judge the quality of the composite and monitor the chemical transformations that take place during the process.

A carbon/carbon composite material is made by pyrolyzing a starting composite of carbon fibers in an organic (often, epoxy or aerosol) matrix. The fibers are relative-

ly pure carbon; they have both a high strength-to-weight ratio and a high solubility parameter that can approach those of diamond. These parameters are related in that the solubility parameter of a material is the square root of its cohesive-energy density. If the initially different solubility parameters, δ , of two materials in contact (in this case, the fibers at $\delta \approx 179 \text{ cal}^{1/2} \text{ cm}^{-3/2}$ and the matrix at $\delta = 9$ to $20 \text{ cal}^{1/2} \text{ cm}^{-3/2}$) become sufficiently close, the materials can mix and then possibly react chemically to form a new material (in this case, a graphitic material that does not have the strength-to-weight ratio of diamond).

During pyrolysis, the fibers remain in an almost-pure-carbon state, while the matrix material loses H_2O , CO_2 , and other by-products, becoming more like pure carbon. The solubility parameter of the matrix therefore increases toward that of pure carbon (see Figure 1), raising the possibility of mixing and chemical reaction between the fibers and matrix. Accordingly, it becomes important to infer the solubility parameters of the composite to assess the chemical composition of its constituents and the relationship between these compositions and the final strength-to-weight ratio of the composite.

In the new method, specimens of the various materials of interest are subjected to infrared reflection spectroscopy (see Figure 2) at wavelengths in the vicinity of $3.3 \mu\text{m}$ — the characteristic absorption

band of carbon/hydrogen bonds. One obtains a reference spectrum from a specimen of cured but unpyrolyzed matrix material and a spectrum from a specimen of the carbonized composite at any desired intermediate stage or after completion of the pyrolysis. Inasmuch as the matrix loses hydrogen during the pyrolysis, one can infer the degree of chemical conversion by comparison of the carbon/hydrogen-bond absorptions computed from the infrared spectra, the processed specimen, and the specimen of unpyrolyzed matrix material. From the infrared absorptions and volume fractions of the constituents, one can infer the solubility parameters of the constituents.

One can also compute an effective solubility parameter for the composite considered as an unitary material. This parameter has significance for subsequent fabrication steps that involve chemical treatments; e.g., coating or joining with adhesives. For example, in a demonstration of the new method, the solubility parameter of a carbon/carbon composite was estimated at $106.8 \text{ cal}^{1/2} \text{ cm}^{-3/2}$, which is the solubility parameter of copper. Copper was deposited on the composite and found to adhere very well.

This work was done by Daniel D. Lawson and Paul M. McElroy of Caltech for NASA's Jet Propulsion Laboratory. For further information, Circle 82 on the TSP Request Card.

NPO-18073

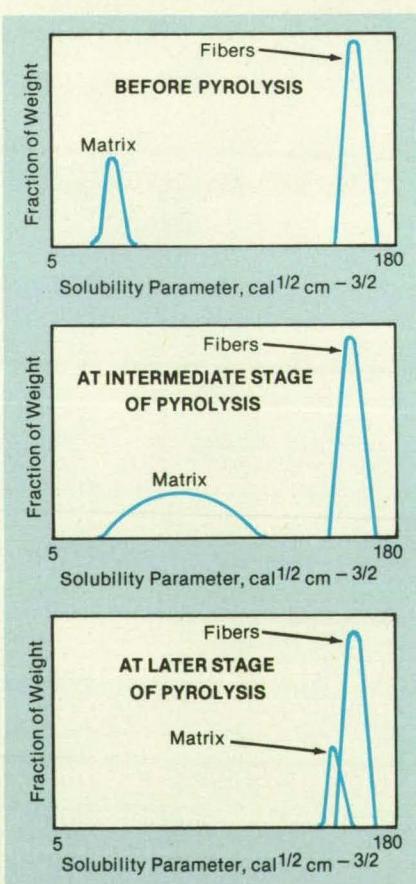


Figure 1. The Solubility-Parameter Spectra of the organic matrix and carbon fibers in a composite of the two move toward each other as the composite is pyrolyzed.

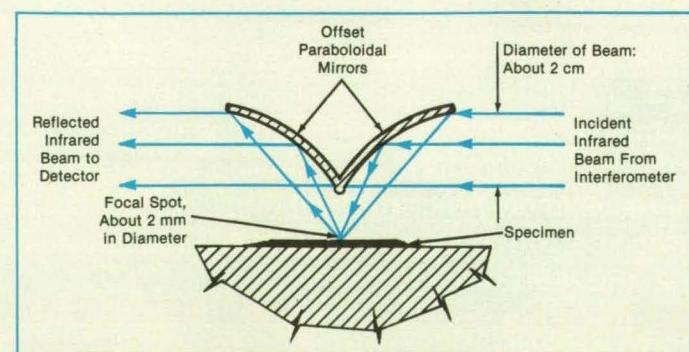
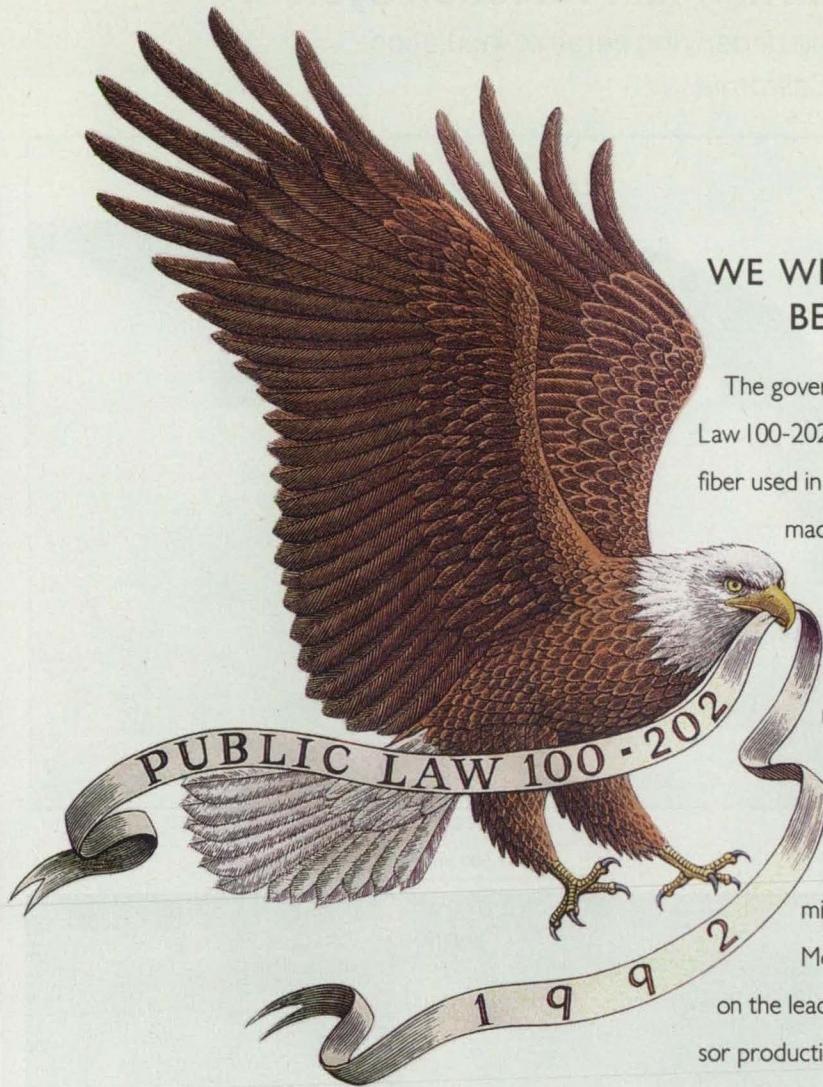


Figure 2. Infrared Reflection Spectroscopy is used to measure the absorption of specimens at wavelengths around $3.3 \mu\text{m}$. From the spectra of reference and pyrolyzed specimens, one can infer the solubility parameters of the pyrolyzed specimens.



WE WERE READY TO OBEY THE LAW BEFORE THERE WAS A LAW.

The government has just implemented Section 8088 of Public Law 100-202. That means by 1992 50% of PAN-based carbon fiber used in Department of Defense programs will have to be made in the U.S. from domestic precursor.

Fortunately, you'll have no trouble complying. Because our PAN carbon fibers have been manufactured from precursor made right here in the United States since 1982. Just last year we added another 1.2 million pounds of capacity to our fully-integrated facilities in Greenville, South Carolina.

Today, we are capable of producing a total of 2 million pounds a year, with plenty of room to grow.

More than just capacity, we also have more experience on the leading edge of PAN fiber technology, including precursor production, than any other American supplier. So no matter what particular properties you're looking for—greater strength, lighter weight, consistency, conductivity, or fatigue resistance—you'll find we may have already explored the possibilities and developed solutions to fit your needs.

To learn more good news about PAN-based THORNEL® carbon fibers including our latest research and development information, call our Customer Service Department at 1-800-222-2448.

We'll be glad to show you there's at least one law that's going to be very easy to obey.

THE ALL AMERICAN SOLUTION



Amoco Performance Products

Circle Reader Action No. 486

Ceramic-Fibrous-Insulation Thermal-Protection System

Graded fibrous composite forms with the underlying ceramic insulation.

Ames Research Center, Moffett Field, California

A new composite thermal-protection system has been developed in which a glass-ceramic was impregnated into the surface of a fibrous insulation. The system called TUFI for toughened unipiece fibrous insulation was developed as a replacement for the currently used tiles with a reaction-cured-glass (RCG) coating. The impregnation of the glass-ceramic results in a thermal protection system with insulating properties comparable to the existing system but with 20 to 100 times more resistance to impact.

The formulation and the application process for TUFI differ from those for RCG. The main ingredients of RCG include silica and boron oxide powders (which form a borosilicate glass) and silicon tetraboride powder (which gives the requisite emittance). These ingredients are mixed in an ethanol carrier to make a slurry, which is sprayed on a tile, dried, then sintered to form a hard, protective surface layer.

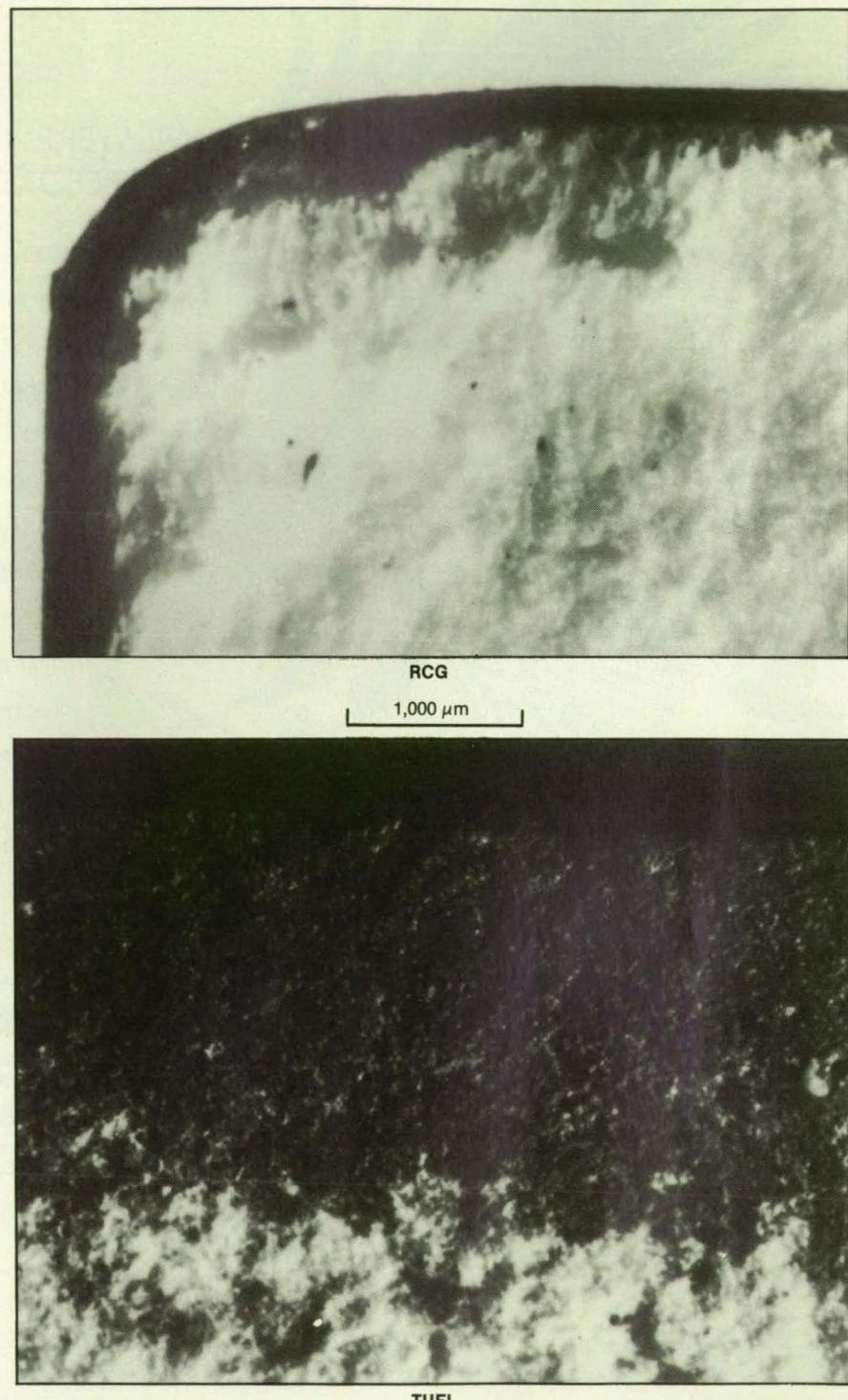
TUFI is also made in part from silica and boron oxide powders and silicon tetraboride in an ethanol slurry. An additional emittance agent — molybdenum disilicide — is included because it is more stable during sintering. The powders are ground more finely than in RCG so that they penetrate the porous tile more deeply. The TUFI slurry is applied in approximately twice the quantity of RCG in three spraying applications to aid penetration.

The many large pores in TUFI inhibit the propagation of cracks from impact sites, thereby increasing toughness. The pores also readily absorb waterproofing materials. TUFI is not simply a surface layer; it is a graded composite fiber-reinforced surface/subsurface layer that blends smoothly with the porous ceramic substrate. Whereas a sharp interface lies between RCG and its substrate, TUFI has a diffuse interface, changing gradually in color from black at the surface to white in the interior (see figure).

In impact tests, the RCG coating cracked in a star pattern at impact energies as small as 0.005 joule. In contrast, in impacts of as much as 0.5 joule on TUFI, damage was limited to the impact sites only. (The precise point at which impact failure occurs in TUFI is difficult to define because of its graded composite nature.)

This work was done by Daniel Leiser, Rex Churchward, Victor Katvala, and David Stewart of Ames Research Center, and Aliza Balter of Eloret Institute. For further information, Circle 69 on the TSP Request Card.

This invention is owned by NASA, and a



The Graded Interface of the Surface Layer with the porous ceramic substrate in TUFI contrasts with the sharp interface of RCG. The TUFI layer is considerably thicker than the RCG layer (about 0.25 cm vs. about 0.03 mm).

patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development

should be addressed to the Patent Counsel, Ames Research Center [see page 14]. Refer to ARC-11888.

For You, from Cole-Parmer



AIRFLOW MEASUREMENT

Nine pages of thermoanemometers; mechanical, analog, and digital anemometers; and the Tri-Sense™ air velocity/temperature/RH meter.



FLOWMETERS

Forty-one pages of variable-area, low-flow gas, turbine, portable Doppler, mass flow, and paddle-wheel flowmeters.



CONDUCTIVITY

Twenty-one pages of conductivity, TDS, H₂O, portable, dual-scale, and S-C-T meters.



ULTRASONIC CLEANERS

Seven pages of cleaners from one-pint to ten-gallon sizes, from pipette washers to industrial tank systems, plus cleaning solutions.



MIXERS

Fifty-one pages of heavy-duty, electronic, high-torque, high-speed, dual-shaft, triple-shaft, fixed-speed, and variable-speed mixers.



pH

Fifty-eight pages of pH, mV, ORP, and ion-selective meters and electrodes for pH measurement and control.

COLE-PARMER®
INSTRUMENT COMPANY

**1991
1992**

CALL TOLL-FREE:
1-800-323-4340

INSTRUMENTS FOR RESEARCH,
INDUSTRY, AND EDUCATION

HONORING THE SCIENTIFIC EDUCATOR



Cole-Parmer® Instrument Company
7425 North Oak Park Avenue
Chicago, Illinois 60648

Send in the attached card for your free 1991-1992 Cole-Parmer catalog. Drop it in the mail today!

Our 1248-page catalog is filled with over 21,000 quality products for research, industry, and education.

To place an order, obtain technical support, or learn more about these NEW products, dial 1-800-323-4340.



LCD CONTACT TACHOMETER
Rotational and linear speed measurement from 1.5 to 10,000 rpm; switchable high/low ranges.
Circle for more information 536



LOW-COST IR THERMOMETER
Infrared measurement with adjustable emissivity, high alarm, max scan, recall, and backlit display.
Circle for more information 535



CENTRIFUGAL PUMP
High-capacity, TEFC pump with sealless magnetic drive, PVDF body, and flow rates to 105 GPM.
Circle for more information 534

For your free catalog, circle 533



Computer Programs

- 52 Eleven-Species Thermochemical Model of Air
- 52 Analyzing Satellite Images of the Ocean
- 54 Vortex-Blob Simulation of Two-Dimensional Flows
- 54 Computer Program for Variable-Conductance Heat Pipes
- 54 Computing Large-Angle Transients in Structures
- 55 Plotting Program for Aerodynamical Computations
- 56 Program Solves Euler Equations of Supersonic Flow
- 56 LOP—Long-Term Orbit Predictor
- 56 Automatic Generation of Countdown-Simulating Software
- 57 Menu-Driven Solver of Linear-Programming Problems
- 57 Software for Generating Graphs and Charts
- 57 Fault-Tree Compiler Program

COSMIC: Transferring NASA Software

COSMIC, NASA's Computer Software Management and Information Center, distributes software developed with NASA funding to industry, other government agencies and academia.

COSMIC's inventory is updated regularly; new programs are reported in *Tech Briefs*. For additional information on any of the programs described here, circle the appropriate TSP number.

If you don't find a program in this issue that meets your needs, call COSMIC directly for a free review of

programs in your area of interest. You can also purchase the annual *COSMIC Software Catalog*, containing descriptions and ordering information for available software.

COSMIC is part of NASA's Technology Utilization Network.

COSMIC John A. Gibson, Director,
Phone (404) 542-3265; FAX (404) 542-4807
The University of Georgia, 382 East Broad Street,
Athens, Georgia 30602

Computer Programs

These programs may be obtained at a very reasonable cost from COSMIC, a facility sponsored by NASA to make computer programs available to the public. For information on program price, size, and availability, circle the reference number on the TSP and COSMIC Request Card in this issue.



Physical Sciences

Eleven-Species Thermochemical Model of Air

The SPECIES program computes thermodynamic and transport properties and equilibrium constants.

The accurate numerical prediction of a high-temperature, chemically reacting flow field requires a knowledge of the physical properties and reaction kinetics for the species involved in the reacting gas mixture. Assuming an 11-species mathematical model of air at temperatures below 30,000 K, SPECIES (Computer Codes for the Evaluation of Thermodynamic Properties, Transport Properties, and Equilibrium Constants of an 11-Species Air Model) computes values for the thermodynamic and transport properties of the species, diffusion coefficients, and collision cross sections for any combination of the 11 species, and rates for the 20 chemical reactions that normally occur among the species.

The species represented in the model are diatomic nitrogen, diatomic oxygen, atomic nitrogen, atomic oxygen, nitric oxide, ionized nitric oxide, the free electron, ionized atomic nitrogen, ionized atomic oxygen, ionized diatomic nitrogen, and ionized diatomic oxygen. Sixteen subroutines

compute the following properties for (1) a single species, interaction pair, or reaction, and (2) an array of all species, pairs, or reactions: specific heat and static enthalpy of the species, viscosity of the species, frozen thermal conductivity of the species, diffusion coefficient, collision cross section (OMEGA 1,1), collision cross section (OMEGA 2,2), ratio between collision cross sections, and equilibrium constant.

The program uses least-squares polynomial curve fits of the most accurate data believed available to provide the requested values more quickly than is possible with table-lookup methods. The subroutines that compute transport coefficients and collision cross sections include additional code to correct for any electron pressure when working with ionic species.

SPECIES was developed in 1990 on a SUN 3/280 computer running the SunOS 3.5 operating system. It is written in standard FORTRAN 77 for use on any computing machine and requires roughly 92 KB of memory.

SUN and SunOS are registered trademarks of Sun Microsystems, Inc.

This program was written by Richard A. Thompson of Langley Research Center and Kam-Pui Lee and Roop N. Gupta of Scientific Research and Technology. For further information, Circle 150 on the TSP Request Card. LAR-14447

Analyzing Satellite Images of the Ocean

A user-interactive program analyzes archival image data for oceanographic research.

PC-SEAPAK is a user-interactive software package specifically developed for the analysis of data from satellites in oceanographic research. The program is used

to process and interpret data obtained from the Nimbus-7/Coastal Zone Color Scanner (CZCS) and the NOAA Advanced Very High Resolution Radiometer (AVHRR). More specifically, PC-SEAPAK is a microcomputer-based image-analysis program that provides the user with a flexible, user-friendly, standardized interface and facilitates relatively low-cost analysis of oceanographic data.

The CZCS scanning radiometer aboard the Nimbus-7 satellite was designed to measure the concentration of photosynthetic pigments and degradation products thereof in the ocean. AVHRR data from the NOAA 6, 7, 9, and 11 satellites are used to compute sea-surface temperatures. The CZCS operated from November 1978 to June 1986. CZCS data may be obtained free of charge from the CZCS archive at NASA/Goddard Space Flight Center. AVHRR data may be purchased through the NOAA Environmental Satellite Data Information Service.

PC-SEAPAK is a collection of over 100 independent programs organized into categories, which include CZCS level-2 analyses, statistical analyses, extraction of data, remapping to standard projections, manipulation of graphics, manipulation of image-board memory, and general utilities. Most programs provide for interaction with the user through menu and command modes and by the use of a mouse. Most programs also provide for the generation of ASCII files for further analysis in spreadsheets, graphics software packages, and the like.

Although PC-SEAPAK was developed on a COMPAQ Deskpro 386/20 computer, it can be run on almost any 386-compatible computer with an AT bus, EGA controller, Intel 80387 coprocessor, and MS-DOS 3.3 or higher. Other requirements include a Matrox MVP-AT image board with appropriate monitor and cables, a Microsoft mouse (serial version), 2-MB random-access memory, and 100-MB hard-disk memory space. Nine-track tape, 8-mm tape, and optical disks are supported and recommended for ingestion of data and backup recording of data. Users who have the commercial software package HALO88 (or a subsequent version) from Media Cybernetics can optionally choose to annotate images.

PC-SEAPAK has been under development since 1988 and is a derivative of VAX-SEAPAK, which has been under development since 1981. Version 3.0 was released in the summer of 1990, and only executable code is distributed. Distribution of PC-SEAPAK is handled through the Computer Software Management and Information Center at the University of Georgia. It is available only as a set of 29 1.2-MB 5.25-in. (13.3-cm) diskettes in IBM PC DOS format. PC-SEAPAK is a copyrighted product with all copyright vested in the National Aeronautics and



Our new recorder comes with everything but complications.

Sitting down with our new WindoGraf® recorder is like sitting down with a trusted friend. WindoGraf is as easy to use as the recorders we've been making—and you've been using—for years.

Nearly everything about WindoGraf is familiar, from its recorder-style speed controls to its bench-top portability. And when it comes to signal conditioning, WindoGraf offers just what you'd expect in a Gould recorder: input-to-output isolation, DC offset (zero suppression), variable sensitivity, and a selection of signal conditioners to meet most physical test requirements. WindoGraf also features a unique CRT display that lets you monitor your signals in real-time without continuously running paper. And if you'd like to see hard copy, press a button to activate WindoGraf's 4-channel thermal array recorder, which also operates in real-time.

Press another button, and your signals are recorded on WindoGraf's built-in disk drive for future review or analysis.



WindoGraf. Just another way Gould is helping you meet your physical test and measurement needs... without complications.

Circle Reader Action No. 484

Yes! Please rush me a **FREE** WindoGraf brochure!

(please print, or affix business card)

NTB 1/92

NAME: _____ TITLE: _____

COMPANY: _____

STREET: _____

CITY: _____ STATE: _____ ZIP: _____

TELEPHONE: _____

Send to: Gould Inc., Test and Measurement Group, 8333 Rockside Road, ValleyView, Ohio 44125, or call (216) 328-7000, Fax (216) 328-7400.

Space Administration. Phar Lap's DOS-Extender run-time version is integrated into nine of the programs. These programs are duplicated only at GSFC under license from Phar Lap. Version 4.0 will be released in the Fall of 1991.

This software package was developed by Charles R. McClain of Goddard Space Flight Center. For further information, Circle 68 on the TSP Request Card. GSC-13320



Mechanics

Vortex-Blob Simulation of Two-Dimensional Flows

Two programs compute flows about bodies of arbitrary shape.

A software package includes two programs: KPD12 and KPD12P. Both programs use the vortex-blob method to simulate flow around solid bodies. KPD12 treats an unbounded domain, while KPD12P treats a domain that has periodicity in one direction. The main advantage of the vortex-blob method is the ability to handle situations involving arbitrary shapes, including multiple bodies. The user supplies only points on the solid boundaries; there is no grid.

The KPD12 program has worked successfully on bluff bodies, stalled wings, and multiple-element airfoils. The KPD12P program has been used successfully on high-solidity separated cascades and on cases of rotating stall in cascades of thin airfoils. However, the programs do not capture such subtle viscous effects as incipient separation and friction drag.

The KPD12 and the KPD12P programs apply the vortex-blob method to time-dependent, high-Reynolds-number flows around solid bodies. Both programs solve the two-dimensional incompressible Navier-Stokes equations, neglecting the viscous effects away from the walls. By creating new vortexes along the wall at every time step, they treat the no-penetration and no-slip boundary conditions while using an influence matrix. The code automatically controls the number of vortexes. Furthermore, the code includes the option of treating the boundary layers by simple integral methods to determine the separation points. The output of KPD12 includes forces, moments, and pressure distributions on the bodies. The output of KPD12P also includes the turning angle and loss of total pressure.

The source code is in Cray FORTRAN and contains a few calls to Cray vector functions, which are vectorized with the

Cray compiler. However, substitutes for these vector functions are provided. The code is set up to plot the bodies, positions of the vortexes, and streamlines by use of the DISSPLA graphics software. The software requires a mainframe computer with at least 589K of memory available running under COS 1.16.

This program was written by Philippe Spalart of Ames Research Center. For further information, Circle 12 on the TSP Request Card. ARC-12810

Computer Program for Variable-Conductance Heat Pipes

VCHPDA solves nonlinear equations to compute transient and steady-state performance.

The VCHPDA computer program was developed in response to the need for accurate and efficient prediction of the performance of variable-conductance heat pipes used in the thermal-control systems of spacecraft. The features that make these heat pipes ideal for applications on spacecraft also make them attractive for non-aerospace uses. The need to understand these devices better arose when four thermal anomalies that occurred on the Communications Technology Satellite were attributed to transient failures in the variable-conductance-heat-pipe system. As a result of investigations into these anomalies, VCHPDA was written to provide accurate mathematical models of the transient as well as the steady-state performance of variable-conductance heat pipes over a wide range of operating conditions.

VCHPDA applies to variable-conductance heat pipes with either cold, wicked or hot, nonwicked gas reservoirs and uses the ideal-gas law and the "flat-front" (negligible vapor diffusion) gas theory. Given the distribution of temperature along the wall of a variable-conductance heat pipe, VCHPDA calculates the length of the gas-blocked region and the temperature of the vapor in the active portion of the heat pipe by solving a set of nonlinear equations for the conservation of energy and mass.

VCHPDA is a collection of subroutines that must be used in conjunction with the lumped-parameter thermal-analyzer program SINDA. The original version, developed in 1980, was written in FORTRAN IV and implemented on a CDC 6000-series computer. The latest version, developed in 1985, is written in FORTRAN 77 and implemented on both an APOLLO computer under AEGIS and a VAX computer under VMS.

This program was written by D. Antoniuk of TRW, Inc., for Lewis Research Center. For further information, Circle 15 on the TSP Request Card. LEW-14933

Computing Large-Angle Transients in Structures

The LATDYN software is applicable to a variety of jointed and unjointed structural configurations.

LATDYN is a computer code for calculating the large-angle transient dynamics of flexible articulating structures and mechanisms that include joints about which members rotate through large angles. LATDYN extends and brings together some of the aspects of finite-element analysis of structures, the dynamics of multiple bodies, and the analysis of control systems — three disciplines that, historically, have been separate. It combines significant portions of their distinct capabilities into one analysis software tool.

The finite-element formulation for flexible bodies in LATDYN extends the conventional finite-element formulation by use of a convected coordinate system to construct the equations of motion. The formulation in LATDYN allows for large displacements and rotations of finite elements subject to the restriction that strains and deformations within each element are small. Also, the finite-element approach implemented in LATDYN provides a convergent path for verifying solutions simply by increasing the density of the computational mesh.

For rigid bodies and joints, LATDYN borrows extensively from methodology used in computing the dynamics of multiple bodies, wherein rigid bodies may be defined and connected together through joints (hinges, ball joints, universal joints, sliders, and the like). Joints can be represented in mathematical models either by constraints or by adding joint degrees of freedom.

To eliminate errors brought about by the separation of the analyses of controls and of structures, LATDYN provides symbolic capabilities for mathematical modeling of control systems integrally with the analysis of dynamics of structures. Its command language contains syntactical structures that perform symbolic operations that are also connected directly with the finite-element model of a structure, bypassing the modal approximation. Thus, when the dynamical equations that represent the model of the structure are integrated, the equations that represent the control system are integrated along with them as part of a coupled system. This procedure also has the side benefit of enabling a dramatic simplification of the user interface for the mathematical modeling of control systems.

The LATDYN software consists of three FORTRAN computer programs: the LATDYN program, the Preprocessor, and the Post-processor. The Preprocessor translates the user's commands into a form that can be

used while the LATDYN program provides the computational core. The Postprocessor enables the user to plot and interactively manage a data base of results of LATDYN analyses of transients. It also includes special facilities for mathematical modeling of control systems and for programming those changes in the model that take place during an analysis sequence.

The documentation of the LATDYN software includes a demonstration problem manual for the evaluation and verification of results and a postprocessor guide. Because the program should be viewed as a byproduct of research on the development of technology, the scope of LATDYN is limited. It does not have a wide library of finite elements, and three-dimensional graphics are not available. Nevertheless, it does have a measure of "user friendliness."

The LATDYN program was developed during an interval of several years and was implemented on a CDC NOS/VE and Convex Unix computer. It is written in FORTRAN 77 and has a virtual-memory requirement of 1.46 MB. The program was validated on a DEC MICROVAX computer operating under VMS 5.2.

This program was written by Jerrold M. Housner and Maria V. Mitchum of Langley Research Center, A. Louis Abrahamson, Che-Wei Chang, Michael G. Powell, and Shih-Chin Wu of COMTEK, and Bradford D. Bingel and Paula M. Theophilos of Computer Sciences Corp. For further information, Circle 34 on the TSP Request Card. LAR-14382

Plotting Program for Aerodynamical Computations

Output data from a panel-method program can be plotted in a variety of formats.

Researchers who construct mathematical models to solve problems in aerodynamics must be able to generate report-quality graphics to present their results effectively. PMAPP, the Panel Method Aerodynamic Plotting Program, has been written by Sterling Software for scientists at NASA's Ames Research Center to plot the results of aerodynamical analyses (flow data) from PMARC (ARC-12642), a program for the computation of three-dimensional flow by a low-order panel method. PMAPP is an interactive, color-capable graphics program designed to work with a variety of computer terminals and printers.

The program accepts unformatted PMARC plot-data files as input. These files store a variety of data, including data on wire-frame geometrical models, data on the geometries of wakes, aerodynamic

parameters defined on the model geometry, and data on off-body velocity scans and streamlines. PMAPP could be used to plot data from other programs, provided that the files that contain those data are defined according to the PMARC conventions.

PMAPP reads the three-dimensional data from the files and produces plots in several formats. Plotting options include plots of three-dimensional geometry with off-body streamlines, off-body velocity scan contours, off-body velocity scan vectors optionally superimposed, and data curves superimposed over two-dimensional sections of the model geometry. A

postprocessor is supplied to remove hidden lines from the three-dimensional appearing plots.

The program includes the Ames Standard Plot (ASP) graphics library to convert the data to be plotted into device-independent plot (DIP) files. A set of file-conversion programs supplied with PMAPP enables plotting on a large selection of equipment including Versatec printers, PostScript printers, QMS and ATI laser printers, Tektronix terminals, and any terminal or computer able to emulate a Tektronix 40xx terminal.

PMAPP is written in FORTRAN77. It was developed on a DEC MicroVAX computer

Widest Bandwidth, Coax & Fiber Mix, Single Control Versatility— What More Should A Router Do?

Last Indefinitely.

For 35 years we've built the toughest, most advanced signal routing switchers in C41, surveillance, simulation, shared data display, and security. Dynasty, Dynasty 100, and DYNA MITE owners will be the first to tell you our systems almost never wear out.

And by advanced we mean:

- Video bandwidth to 135 MHz.
- Mix fiber and coax within any system.
- One control for all bandwidths.
- Switch NTSC, PAL, Digital, HDTV, Computer Graphics.



No one else but DYNAIR lets you plan years ahead with such wideband confidence and trust. You can't ask for much more than that. For a reliable solution now call **1-800-854-2831**.

DYNAIR
DYNAIR Electronics, Inc.
5275 Market St.
San Diego, CA 92114



with the VMS 4.6 operating system and is designed to run on any VAX or MicroVAX computer with the VMS operating system. PMAPP requires the TCS (Tektronix Control Sequence) library, available through Tektronix, to display data on terminal screens and to create geometrical plots with hidden lines removed.

This program was written by L. J. Wigren and P. K. Lovely of Sterling Software for Ames Research Center. For further information, Circle 138 on the TSP Request Card.

ARC-12751

Program Solves Euler Equations of Supersonic Flow

EMTAC features an efficient space-marching solution technique.

The analysis of supersonic flow over a three-dimensional surface, such as that of a jet fighter or the Space Shuttle, is efficiently mathematically modeled by space-marching techniques. The EMTAC (Euler Marching Technique For Accurate Computation) computer program employs an Euler marching algorithm for computing supersonic flows. This algorithm enables accurate nonlinear analysis of the nonlinear dynamics of supersonic flow over a wide range of supersonic mach numbers and angles of attack. The EMTAC program is based on the exact equations of the dynamics of an inviscid gas and is valid for computations of flows at low and high supersonic mach numbers that exhibit strong shocks and rotational effects.

SIMP (Supersonic Implicit Marching Program For Nonlinear Full Potential Analysis, LAR-13413) is a program capable of handling subsonic pockets near the canopy, the junction between the wing and body, the leading edge of the wing, and the tip of the wing at low supersonic mach numbers. However, because of assumptions of isentropy, SIMP is unable to handle strongly shocked flows with rotational and vortex effects. The EMTAC and SIMP programs have been extensively validated against each other in the range of mach numbers at which the assumptions of isentropy are valid.

The EMTAC program features an efficient space-marching technique based on Euler equations of unsteady flow. Finite-volume implementations of total-variation-diminishing discretizations that have high accuracies (up to third order) are used to make the technique more accurate and reliable than are other Euler space-marching and time-marching techniques that are based on central-difference approximations. EMTAC incorporates a planar Gauss-

Seidel relaxation method that reduces to a simple marching technique in supersonic parts of the flow field. In subsonic parts, both forward and backward Gauss-Seidel sweeps are used. The EMTAC program can also be easily used for inviscid three-dimensional flows that are fully subsonic or transonic (subsonic with super sonic pockets).

EMTAC is written in FORTRAN V and is intended for use on supercomputers that have the ability to utilize UPDATE directives. After the UPDATE directives are used to change parameters and boundary conditions, the program can be used on a smaller computer such as a VAX. A sample UPDATE file and modified source code are included as examples on the distribution tape. The modified source code was created by using the UPDATE directives on a CYBER 960 computer running NOS and has been successfully implemented on a MicroVAX 3600 computer under the VMS operating system. EMTAC was developed in 1987.

VAX, MicroVAX, and VMS are trademarks of Digital Equipment Corp. CYBER 960 and NOS are trademarks of Control Data Corp.

This program was written by Kuo-Yen Szema, Sukumar Chakravarthy, and Vijaya Shankar of Rockwell International Corp. for Langley Research Center. For further information, Circle 35 on the TSP Request Card.

LAR-14228

LOP — Long-Term Orbit Predictor

This program computes long trajectories of spacecraft around planets.

The Long-Term Orbit Predictor (LOP) trajectory-propagation computer program is a useful tool in analysis of the lifetime of an orbiting spacecraft. LOP is suitable for studying planetary-orbit missions with reconnaissance (flyby) and exploratory (mapping) trajectories. LOP includes sample data for a study of the drift cycle of a geosynchronous station, a strategy for radar mapping of Venus, a frozen orbit about Mars, and an orbit characterized by a repeating ground trace.

LOP is based on the use of the variation-of-parameters method in the formulation of the equations of motion. Terms that involve the mean anomaly are removed from numerical integrations so that large step sizes, on the order of days, are possible. Consequently, LOP can be executed much faster than can such programs based on Cowell's method as the companion program ASAP (the Artificial Satellite Analysis Program, NPO-17522, also available through COSMIC). LOP incorporates a force model

with a gravity field of up to 21 by 21, lunisolar perturbation, drag, and solar-radiation pressure.

The input includes classical orbital elements (either mean or oscillating), orbital elements of the Sun relative to the planet, reference time and dates, drag coefficients, gravitational constants, radius of the planet, and rate of rotation of the planet. The printed output contains the classical elements for each time step or event step, and such additional orbital data as true anomaly, eccentric anomaly, latitude, longitude, periaxis altitude, and the rate of change per day of certain elements. In addition, selected items of output are written to a plot file for postprocessing by the user.

LOP is written in FORTRAN 77 (requiring the Lahey F77 V2.0 compiler and Microsoft Linker V3.3X) for batch execution on an IBM PC-series computer operating under a version of DOS and requires a minimum central random-access memory of 256 KB. The LOP software package includes examples that use LOTUS 1-2-3 for graphical displays, but any graphics software package should be able to handle the ASCII plot file. The LOP program was written in 1986 and last updated in 1989.

This program was written by Johnny H. Kwok of Caltech for NASA's Jet Propulsion Laboratory. For further information, Circle 65 on the TSP Request Card.

NPO-17052



Mathematics and Information Sciences

Automatic Generation of Countdown-Simulating Software

The ANPS program generates simulation programs from the user's specifications.

The development of some of the large simulation projects of the space program — like the project that involves the simulation of the countdown sequence prior to the lift-off of a spacecraft — requires the support of automated software and techniques. The number of preconditions that must be met for a successful spacecraft launch and the complexity of interrelationships among these preconditions account for the difficulty of creating an accurate mathematical model of the countdown sequence. Researchers have developed the ANPS computer program for the NASA Marshall Space Flight Center to assist programmers who are attempting to model the prelaunch countdown sequence. ANPS is designed to write simulation programs for problems concerning the pre-launch activities of space vehicles and the

operation of ground support equipment and has potential for use in developing network-reliability models for systems and subsystems of equipment.

Incorporating the elements of automatic programming as its foundation, ANPS aids the user in defining the problem and then automatically writes the appropriate simulation program in GPSS/PC code. The interactive user-dialogue interface of this program creates an internal problem-specification file from the user's responses. This file includes the time line for the countdown sequence, the attributes of the individual activities that are part of a launch, and the relationships of dependency among the activities. The automatic simulation-code generator of the program receives the file as input and selects appropriate macroinstructions from a library of software modules to generate the simulation code in the target language GPSS/PC. The user can recall the problem-specification file for modification to effect any desired changes in the source code.

ANPS was developed in 1988 for use on IBM-PC or compatible computers. The program requires at least 640 KB memory and one 360-KB disk drive, PC DOS Version 2.0 or above, and GPSS/PC System Version 2.0 from Minuteman Software. The program is written in Turbo Prolog Version 2.0.

GPSS/PC is a trademark of Minuteman Software. Turbo Prolog is a trademark of Borland International. IBM-PC and PS DOS are registered trademarks of International Business Machines Corporation.

This program was written by Bernard J. Schroer, Shou X. Zhang, and Fan T. Tseng of Marshall Space Flight Center. For further information, Circle 85 on the TSP Request Card.

MFS-26091

Menu-Driven Solver of Linear-Programming Problems

This program assists the inexperienced user in formulating linear-programming problems.

Linear programming is a widely used engineering and management tool. Scheduling, allocating resources, and planning production are all well-known applications of linear programs (LP's). Because most linear-programming problems are too large to be solved by hand, over the decades many computer codes have been developed to solve such problems.

The A Linear Program Solver (ALPS) computer program is a full-featured LP analysis program. ALPS can solve plain linear-programming problems as well as

more-complicated mixed-integer and pure-integer programs. ALPS also contains an efficient technique for the solution of purely binary linear-programming problems.

One of the many weaknesses of computer programs for the solution of linear-programming problems ("LP solvers," for short) is the lack of interaction with the user. ALPS is a menu-driven program, with no special commands or keywords to learn. In addition, ALPS contains a full-screen editor to enter and maintain the LP formulation. ALPS provides for portability, in that formulations can be written to and read from plain ASCII files. For users less experienced in LP formulation, ALPS contains a problem "parser," which checks formulations for errors. ALPS creates fully formatted, readable reports that can be sent to a printer or output file.

ALPS is written entirely in IBM's APL2/PC software, Version 1.01. The program exists in two forms. The APL2 workspace program, which contains all the ALPS code, can be run on any APL2/PC system (AT or 386). This configuration, on a 32-bit system, can take advantage of all extended memory. The user can also examine and modify the ALPS code. Alternately, the APL2 workspace program has been "packed" to be run on any DOS system (without APL2) as a stand-alone "EXE" file, but has limited memory capacity on a 640K system. A numeric coprocessor (80×87) is optional but recommended. The packed program contains licensed material that is the property of IBM (copyright 1988, all rights reserved).

This program was written by L. A. Viterna of Lewis Research Center and D. Ferencz of Case Western Reserve University. For further information, Circle 5 on the TSP Request Card.

LEW-14978

Software for Generating Graphs and Charts

Plots and pie charts can be generated quickly.

The Common Graphics Library (CGL) computer program is designed to enable users to generate graphs and charts of quality sufficient for publication or optical projection. CGL quickly and easily generates linear, logarithmic, bar, pie, and composite charts. Features of linear charts include automatic scaling, increasing or decreasing numerical axes, and character axes. Features of pie charts include segment labels, exploded segments, and chart keys. One of the general features is horizontal or vertical orientation of figures.

The CGL program has two user-interface levels. The Langley Easy (LEZ) routines provide a simple way to generate complete charts of quality sufficient for use

in reports. Special knowledge of CGL or of DI-3000 graphics software library supplied by the user is not required. The second user interface enables the user to manipulate components of charts and design specific charts for unique or unusual purposes.

CGL version 2.1 was written in 1988 in ANSI FORTRAN 77 and requires the commercial graphics software package DI-3000 (Precision Visuals) as the underlying graphics package. CGL is therefore machine-independent within the support range of the DI-3000 software.

This program was written by Dana P. Hammond, Alicia S. Hofler, David L. Miner, and Pauline M. Theophilos of Computer Sciences Corp. and Nancy L. Taylor of Langley Research Center. For further information, Circle 110 on the TSP Request Card.

LAR-14505

Fault-Tree Compiler Program

This program facilitates the description of a fault tree and speeds analysis.

FTC, the Fault-Tree Compiler program, is a reliability-analysis software tool used to calculate the probability of the top event of a fault tree. Five different types of gates are allowed in the fault tree: AND, OR, EXCLUSIVE OR, INVERT, and M OF N. The high-level input language of FTC is easy to understand and use. In addition, the program supports a hierarchical fault-tree-definition feature that simplifies the process of description of the tree and reduces execution time.

A rigorous error bound is derived for the solution technique. This bound enables the program to supply an answer with a precision (within the limits of double-precision floating-point arithmetic) of a number of digits specified by the user. The program also facilitates sensitivity analysis with respect to any specified parameter of the fault tree, such as a rate of failure of a component or the probability of a specific event, by enabling the user to vary one rate of failure or the probability of failure over a range of values and plot the results.

The solution technique is implemented in FORTRAN, and the user interface is in Pascal. The program is written to run on a DEC VAX computer operating under the VMS operating system and uses 143K of memory. FTC was developed in 1989.

DEC, VAX, and VMS are trademarks of Digital Equipment Corp.

This program was written by Ricky W. Butler of Langley Research Center and Anna L. Martensen of PRC Kentron, Inc. For further information, Circle 31 on the TSP Request Card.

LAR-14586



Mechanics

Hardware, Techniques, and Processes

- 58 Acoustic Measurement of Periodic Motion of Levitated Object
- 58 Rapidly Deployable Enclosure

- 59 Two-Dimensional Vernier Scale
- 60 Ribbon Cable Strap Partly Free of Backlash
- 61 Lubricant for Use in Liquid Oxygen
- 61 Stall-Departure-Resistance Enhancer
- 62 Gauge Measures Large Spherical Bearing Surfaces

Books and Reports

- 63 Rotodynamic Behavior of Sawtooth-Pattern Damping Seals
- 63 Bifurcations in Unsteady Flows
- 63 More About Nonobstructive Particle Damping
- 64 Finding the Laminar-to-Turbulent Transition
- 64 An Implementation of the Solution-Adaptive-Grid Method

Computer Programs

- 54 Vortex-Blob Simulation of Two-Dimensional Flows
- 54 Computer Program for Variable-Conductance Heat Pipes
- 54 Computing Large-Angle Transients in Structures
- 55 Plotting Program for Aerodynamical Computations
- 56 Program Solves Euler Equations of Supersonic Flow
- 56 LOP—Long-Term Orbit Predictor

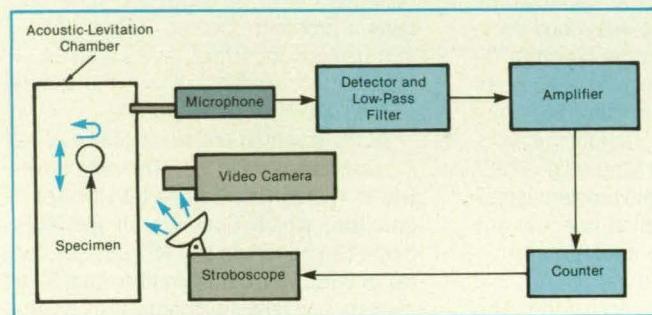
Acoustic Measurement of Periodic Motion of Levitated Object

The levitating acoustic signal is modulated by object motion of lower frequency.

NASA's Jet Propulsion Laboratory, Pasadena, California

Some internal vibrations, oscillations in position, and rotations of an acoustically levitated object can be measured by use of a microphone that is already installed in a typical levitation chamber for tuning the chamber to resonance and monitoring its operation. The motions in question are usually characterized by frequencies less than that of the levitating acoustic carrier signal. These motions affect the acoustic field in such a way as to cause amplitude modulation of the carrier signal in the output of the microphone. The amplitude modulation can be detected and analyzed spectrally to determine the amplitudes and frequencies of the motions.

The figure illustrates an experiment that was performed to verify this measurement concept. A specimen was levitated in a 20-kHz sound field and made to undergo a stable vertical vibration. The output of the microphone was filtered and amplified,



and the peaks of the amplified signal were counted to determine the frequency of the modulation. A stroboscope aimed at the specimen and synchronized with the counting pulses was used to verify that the counter was reading the frequency of vibration.

This work was done by John L. Watkins and Martin B. Barmatz of Caltech and NASA's Jet Propulsion Laboratory. For

Some Translational and Rotational Oscillations of the specimen were detected via amplitude modulation of the levitating signal. That the oscillations of the specimen were synchronous with the modulation was verified stroboscopically.

further information, Circle 130 on the TSP Request Card.

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, NASA Resident Office-JPL [see page 14]. Refer to NPO-18191.

Rapidly Deployable Enclosure

Balloons expand to surround and seal off equipment.

Marshall Space Flight Center, Alabama

A lightweight temporary enclosure protects equipment from immersion in seawater or contact with harmful atmospheres or other corrosive media. The enclosure can be fully deployed within a few seconds.

The undeployed enclosure consists of a folded balloon on the circumference of a circular housing (see figure). At the moment of deployment, a chemically inert gas (helium in the original application) is forced into the balloon. As the balloon expands, it forces open magnetic or clamping seals on the doors of the housing and bursts outward to surround the equipment. Expansion takes about 1 s.

When expansion is complete, a motor retracts a pull cord that encircles the open end of the balloon. This action cinches a closure flap shut and draws the cinched flap through a "bear-trap" clamp. The clamp, which has a stiff spring, snaps shut after a preset length of flap enters it, thereby forming a water- and gas-tight seal. The entire deployment process takes only 4 s.

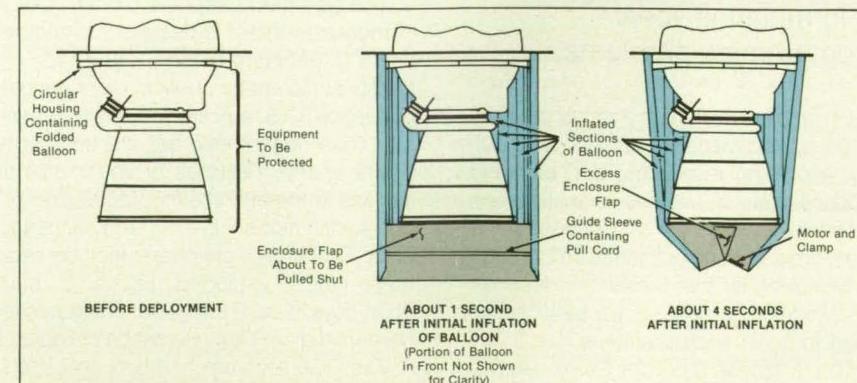
The enclosure was conceived to shield

a rocket booster from ocean water when it is dropped in the ocean after launching a spacecraft. The enclosure would make it unnecessary to refurbish the booster after recovering it from the ocean. The shape of the housing balloon could, presumably, be adapted to suit terrestrial equipment that must be shielded quickly

against impending immersion.

This work was done by Walter L. Rournier and N. Frank Burgy of United Technologies Corp. for Marshall Space Flight Center. For further information, Circle 30 on the TSP Request Card.

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Marshall Space Flight Center [see page 14]. Refer to MFS-28512.



The Housing of the Undeployed Enclosure encircles the equipment to be enclosed. The deployed enclosure surrounds the equipment and seals it from the environment.

Two-Dimensional Vernier Scale

Simple manipulation of a pair of overlays gives accurate readings of coordinates in two dimensions.

Lyndon B. Johnson Space Center, Houston, Texas

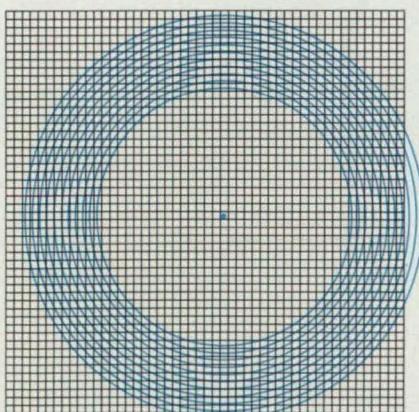
A modified vernier scale gives accurate two-dimensional coordinates from maps, drawings, or cathode-ray-tube displays. Like the linear vernier caliper familiar to machinists and mechanical engineers, the scale enables the user to interpolate between the finest divisions of a regularly spaced rule simply by observing which mark on an auxiliary vernier rule aligns with a mark on the primary rule.

The tool consists of two transparent overlays: a fixed one containing a cartesian grid and a movable one containing concentric circles (see figure). The space between the circles is nine-tenths that between the lines of the grid (the same as on the auxiliary rule on the conventional one-dimensional vernier caliper).

The user places the center of the circles on the point, the coordinates of which are to be measured. The user observes the x and y values of the grid lines nearest the point and interpolates to additional significant figures by noting the x and y values of the grid lines with which the circles coincide. The measurements are done easily and quickly.

The movable overlay can contain a second cartesian grid instead of circles and can be used in the same way — by noting the coincidences of lines on the fixed and movable overlay. However, the movable grid would have to be kept in strict orthogonal alignment with the fixed grid. This requirement does not apply to the circular grid; the accuracy of its measurement is unaffected by rotation.

The method can be adapted to non-cartesian grids — for example, a slanted grid that is a linear transformation of a cartesian grid. The circles on the movable



The Movable Circular Overlay Rests on a fixed rectangular-grid overlay. The pitch of the circles is nine-tenths that of the grid and, for greatest accuracy, the radii of the circles are large compared with the pitch of the grid.

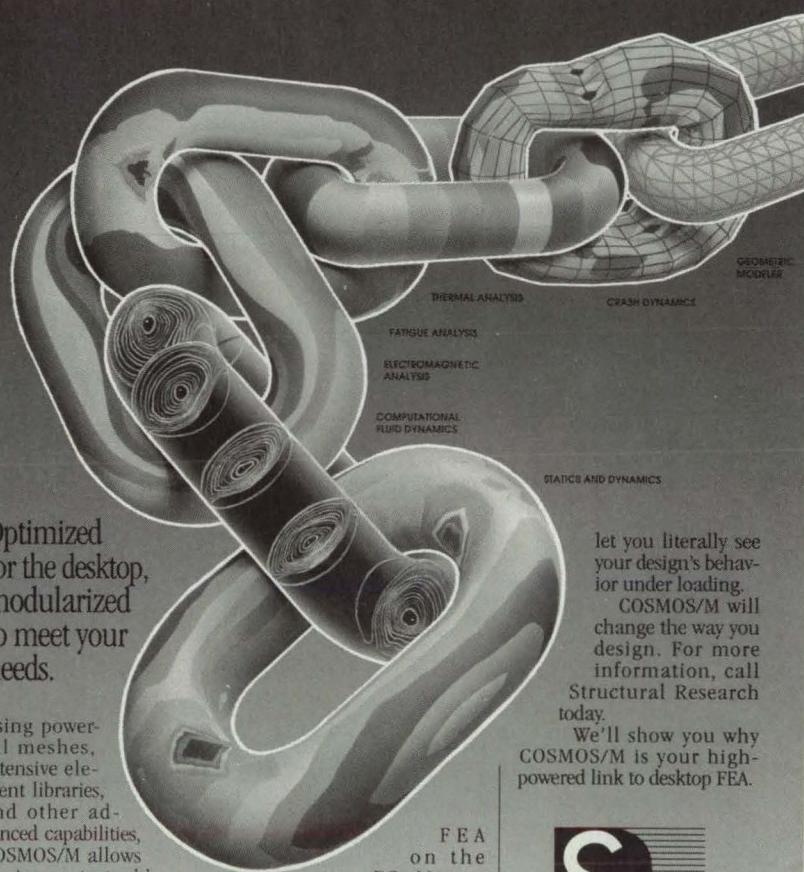
overlay would be calculated as for the cartesian grid, then modified according to the same linear transformation. In this case, interpolation would be done by noting the coincidences of ellipses with lines. In this case, the ellipses would have to be maintained in angular alignment with the fixed grid.

This work was done by Richard D. Judy

of Johnson Space Center. For further information, Circle 55 on the TSP Request Card.

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Johnson Space Center [see page 14]. Refer to MSC-21700.

COSMOS/M: The Link to FEA.



Using powerful meshes, extensive element libraries, and other advanced capabilities, COSMOS/M allows engineers to tackle complex problems — and dramatically cut design and engineering lead times. Linear and nonlinear statics and dynamics, thermal, fatigue, computational fluid dynamics, electromagnetics and design optimization — whatever your requirements, COSMOS/M is your link to

FEA on the PC, Mac or workstation. Icons, windows, pull-down menus and online help make using COSMOS/M simple and straightforward for experienced and new users alike. High-productivity capabilities significantly reduce the analysis cycle, and color plots, graphs and animation

let you literally see your design's behavior under loading.

COSMOS/M will change the way you design. For more information, call Structural Research today.

We'll show you why COSMOS/M is your high-powered link to desktop FEA.



1661 Lincoln Boulevard, Suite 200
Santa Monica, CA 90404
(213) 452-2158 FAX (213) 399-6421
Telex 705578

East Coast Office: (412) 967-0958

A PROGRAMMABLE TRANSFORMER WITH A MIND OF ITS OWN.



ESI's Model 73 Precision Ratio Transformer offers superior performance for automated or manual AC calibration of ratio dividers, transformer standards, synchro standards, transformers, calibrators and voltmeters. With a terminal linearity better than 0.5ppm, this seven-decade AC voltage divider gives you 0.1ppm resolution for ratio settings from -0.0010000 to 1.0009999. A 2.5V/Hz option extends resolution to eight decades and allows operation at higher voltages and lower frequencies.

Call us toll-free for more information,

(800) 547-1863.

In Oregon,
(503) 641-4141.

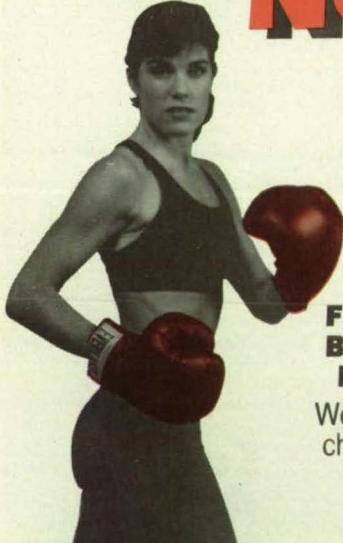
partners in precision



Electro Scientific Industries, Inc.
13900 NW Science Park Drive • Portland, OR 97229

Circle Reader Action No. 625

Knock Out NOISE



AZ-USA delivers the Knock Out punch to noise. **AZ-USA**, the noise control experts offer...

LOWER prices,
FASTER delivery,
FRIENDLIER service,
BETTER performance,
IMPROVED designs.

We are the noise control champions. Let us help you fight your noise control problems.

SATISFACTION GUARANTEED

Call AZ-USA Toll Free
for a FREE brochure.

1-800-842-9790

AZ-USA

Noise Reduction From A to Z

60 Circle Reader Action No. 478

1401 W. 76th Street
Suite 250
Minneapolis, MN 55432
Phone: 612 861-2290
Fax: 612 861-2103

© 1991 AZ-USA, Inc.

Ribbon Cable Strap Partly Free of Backlash

A connection across a limited-rotation joint operates at cryogenic temperatures.

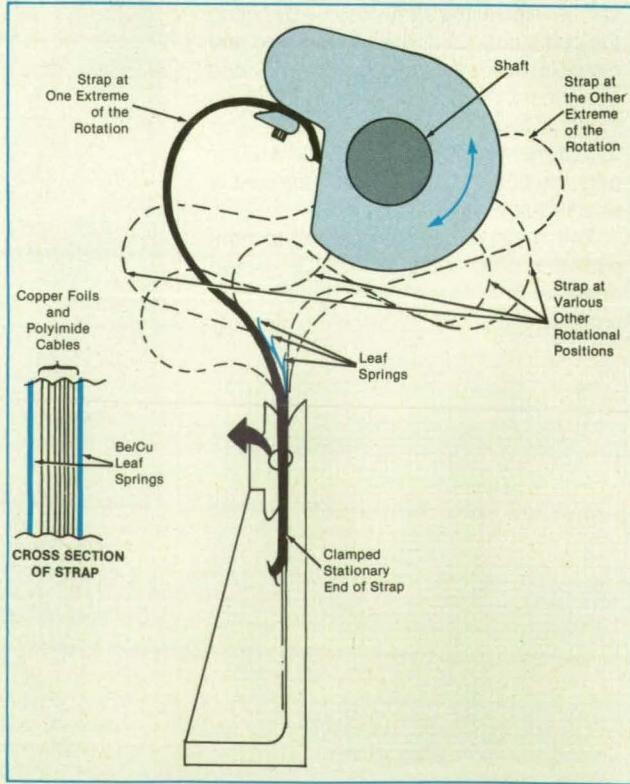
*Goddard Space Flight Center,
Greenbelt, Maryland*

A flexible ribbon cable strap carries heat and electrical signals across a rotational shaft without creating backlash torques at both extremes of rotation through a limited angular range. The strap keeps its flexibility and nonbacklash properties at cryogenic temperatures. It thus can be used to connect delicate equipment, such as movable infrared sensors, that require precise positioning.

The strap consists of layers of 30 gold-plated copper foils and 3 polyimide ribbon cables. At its stationary end, the strap is sandwiched between beryllium/copper leaf springs (see figure). At one extreme of the rotary motion, the strap is curved like a question mark. At the other extreme of the rotary motion (217° from the first extreme), the strap forms a reverse question mark. Both extreme positions are stable in that the strap produces zero torque there. The leaf springs act in concert with an offset of the stationary end of the strap from centerline of the shaft to eliminate undesirable snapping of the strap as the shaft rotates from one extreme position to the other.

A strap of this type can readily be adapted to a greater or lesser angular travel by changing its length and offset and the bias of the ribbon cables.

This work was done by Rodger Farley and Armando Morell of Goddard Space Flight Center. For further information, Circle 49 on the TSP Request Card. GSC-13371



The **Ribbon Strap** is designed to exert no backlash torque at two extreme positions of limited rotation at the temperature of liquid helium. The copper foils provide ample cross section for the transfer of heat. The leaf springs stop the strap from snapping as it passes from one extreme position to the other.

NASA Tech Briefs, January 1992

Lubricant for Use in Liquid Oxygen

An inexpensive grease extends the lives of bearings in a turbopump.

Marshall Space Flight Center, Alabama

An inexpensive grease, Braycote 640 AC-MS (or equivalent), increases the operating lifetimes of ball bearings in a liquid-oxygen turbopump. In a demonstration, the grease was used in 57-mm bearings. After operation from 27,000 to 31,500 rpm for 25,700 s, the balls showed no signs of wear and had lost a negligible amount of weight. In contrast, under the same operating conditions, balls lubricated by fluoroethylpolypropylene solid lubricant coating on glass-filled polytetrafluoroethylene separators showed obvious surface distress after only 1,440 s and had lost 270 mg of material (see figure).

The fluoroethylpropylene coating process cost about \$150 per bearing cage (1990 prices). Implantation of ions in balls and raceways runs \$10,000 per bearing and yields only limited improvement in life expectancy. The new grease costs less than 50 cents per bearing (1990 prices).

The fluoroethylpropylene coating on a cage provides only a small reservoir of lubricant. When it is consumed, the balls scrub the separator, exposing the fiber-glass reinforcement in it. The balls then wear faster.

The improved grease can be stored and supplied very efficiently. The addition of a

coat of the grease only 3 to 4 mils (0.08 to 0.10 mm) thick to the surfaces of the separator pockets is sufficient. In the cryogenic liquid, the grease film freezes. However, during operation, the balls are warm and melt the grease upon contact so that an ultrathin film of the grease comes to adhere to each ball. The ball carries the film to the raceway, where it lubricates the contact surface.

This work was done by Robert F. Beatty and Scott E. McVey of Rockwell International Corp. for **Marshall Space Flight Center**. For further information, Circle 28 on the TSP Request Card.

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Marshall Space Flight Center [see page 14]. Refer to MFS-29760.



- Operated for 1,440 s
- Lubricated With Fluoroethylpropylene
- Obvious Surface Distress
- 270 mg Lost



- Operated for 25,700 s
- Lubricated with Special Grease
- Little Surface Distress
- Negligible Loss of Material

Decreased Wear is evident in bearing balls lubricated by a grease compatible with liquid oxygen. Balls lubricated by fluoroethylpropylene showed pronounced wear after only 24 min.

Stall-Departure-Resistance Enhancer

A device enhances spin resistance and increases lift at poststall angles of attack.

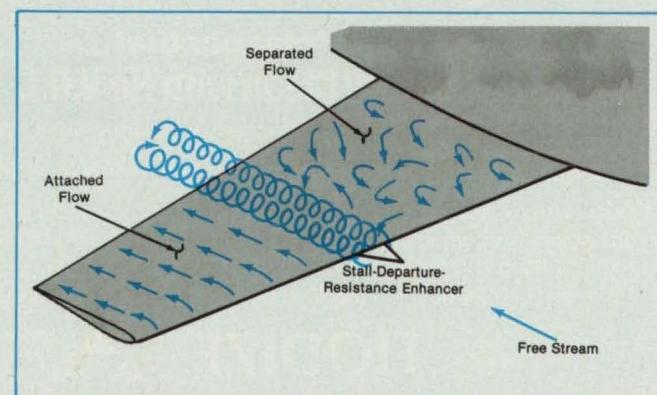
Langley Research Center, Hampton, Virginia

The stall-departure-resistance enhancer is a device that improves the stall departure resistance of aircraft operating at or near the stall angle of attack of a wing. The device induces vortical flow over the upper surface of the wing. Vortex generators of various configurations have been used to delay or control the separation of flows on wings. Previous devices typically consisted of small wedges on and perpendicular to the upper surfaces of wings.

The stall-departure-resistance enhancer, as specified in a new design developed at NASA Langley Research Center, is placed at the leading edge of a wing to create vortexes over the upper surface of the wing at near-stall conditions. The wedge delays

The **Stall-Departure-Resistance Enhancer** imposes a lesser drag penalty than do nortex generators of older types. It increases lift by as much as 30 percent at angles of attack that would otherwise be in the poststall region.

stall by preventing the wing lift from suddenly decreasing after the angle of attack of the wing increases beyond what would



otherwise be the stall angle. The vortical flow produced by the wedge adds energy to the boundary layer by mixing some of

the high-energy fluid from the external flow into the low-energy shear layer near the upper surface of the wing and acts as an aerodynamic fence that prevents separated flow from spreading to the outboard portion of the wing (see figure). Thus, the flow about the outboard portion of the wing remains attached at higher angles of attack, and the stall departure resistance of the airplane is increased.

The device is a flat plate wedge with a 60° sweep angle and is attached so that it protrudes from the leading edge of the wing. The tip is a sharp point, and the edges are made thin and sharp to induce good vortical flow. When the device is mounted on a wing, the centerline of the device should be aligned with the free-stream direction. A test conducted at the

NASA Langley 12-ft (3.7-m) Low-Speed Wind Tunnel showed the device to work very well on a wing with a leading-edge-sweep angle of 26°. Flow-visualization techniques showed that it produced vortices that kept the flow organized at higher angles of attack.

An improved design includes a hinged attachment so that the device is aligned with the freestream at low angles of attack. As the stall angle of attack is approached, the device encounters a limiter, which sets the device at an angle of attack to induce vortical flow. The advantage of this type of device is that the hinged action tends to minimize the cruise- or climb-performance penalties.

Obvious applications include those intended to increase safety for a broad range

of aircraft, including trainers, fighters, general-aviation aircraft, and commercial transport aircraft. The device may also have nonaerospace applications where flow stall is a problem under certain conditions, such as in the control of separation in flow diffusers. There may also be other applications in fluid machinery and fluid flow.

This work was done by Holly M. Ross of Lockheed Engineering and Sciences Co. and Joseph L. Johnson, Jr., Long P. Yip, and H. Paul Stough III of Langley Research Center. For further information, Circle 145 on the TSP Request Card.

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Langley Research Center [see page 14]. Refer to LAR-14221.

Gauge Measures Large Spherical Bearing Surfaces

Radii can be determined without time-consuming electronic inspections.

John F. Kennedy Space Center, Florida

A simple mechanical tool provides data on the radii of large exterior spherical bearing surfaces. The tool can be used onsite, so that it is unnecessary to ship bearings to a laboratory for examination by computerized test equipment.

The tool is, in essence, a four-point measuring device (in principle, four points determine a sphere). The tool consists of

a depth gauge on a platform supported by three precise tooling balls. These balls are placed in contact with the nominally spherical bearing surface to be measured, the depth gauge is moved inward until it makes contact with the bearing surface, and the reading of the depth gauge is recorded. If necessary, this procedure can be repeated, obtaining depth-gauge readings at

several positions to obtain indications of deviations from sphericity and/or from regularity. Point-to-point variations manifest themselves directly as variations in the depth-gauge surface readings, and the spherical radius at each point can be calculated from the reading. The tool is calibrated before its first use by using it on a reference bearing traceable to the National Institute of Standards and Technology.

This work was done by George L. Davis of Lockheed Space Operations Co. for Kennedy Space Center. For further information, Circle 76 on the TSP Request Card. KSC-11485



**The "AWESOME" cleaner that...
Degreasers Safety Clean with No V.O.C. Problems**

D99 removes grease while meeting today's environmental standards. D99 is:

BIODEGRADABLE • NON-FLAMMABLE • NON-ABRASIVE • NON-CAUSTIC

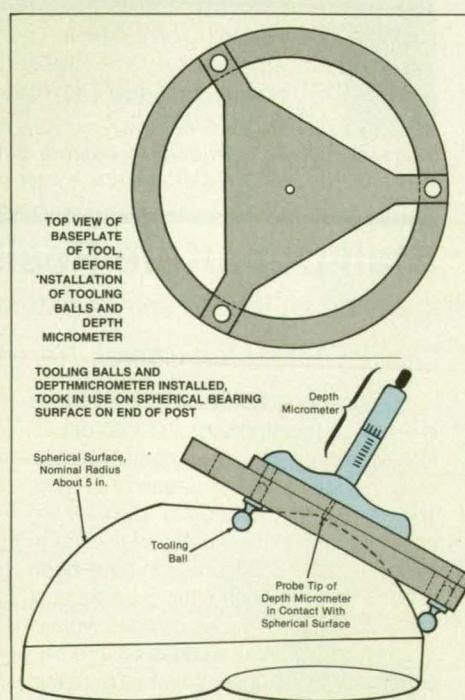
D99 is an excellent grease buster on metal parts, machinery, factory floors, driveways and wherever grease is found. D99 will also remove grease from rugs, clothing and many other materials.

Contact TIODIZE or your local distributor for free information.

TIODIZE®

15701 INDUSTRY LANE • HUNTINGTON BEACH, CA 92649
(714) 898-4377 • FAX: (714) 891-7467

Circle Reader Action No. 422



The Radius of the Spherical Portion of the surface can be computed from the reading of the depth gauge. The measuring tool is calibrated by applying it to a reference spherical surface of the known radius.

Books and Reports

These reports, studies, handbooks are available from NASA as Technical Support Packages (TSP's) when a Request Card number is cited; otherwise they are available from the National Technical Information Service.

Rotordynamic Behavior of Sawtooth-Pattern Damping Seals

Hole-pattern damping seals are probably better.

A report describes a comparative experimental and theoretical study of the rotordynamics of several different annular liquid pump seals. A seal of this type resembles a journal bearing except that it has a larger radial gap, along which the lubricating fluid is pumped, usually with enough axial pressure drop to make the flow in the gap turbulent. In addition, a damping seal exhibits significant direct stiffness (in effect, radial centering stiffness).

The performance of an annular liquid pump seal is usually characterized in terms of the rotordynamic coefficients of a linearized small-lateral-displacement mathematical model. In addition to the direct stiffness, these coefficients include the direct damping and cross-coupling stiffness and damping, which expresses the coupling between a motion in one direction perpendicular to the axis of the shaft and the reaction force that such a motion produces in the other direction perpendicular to the axis. Performance is also characterized with respect to the volume rate of flow (leakage) of fluid along the seal.

A damping seal is an annular liquid pump seal in which the inner surface of the stator (which is the outer member) is roughened to reduce the asymptotic circumferential velocities of fluid in the gap. This, in turn, is intended to reduce the cross-coupling stiffness and the destabilizing force that it causes, thereby increasing the rotordynamic stability. In a previous study directed toward increasing rotordynamic stability, promising theoretical and experimental results were obtained by pockmarking the inner surface of the stator with many small round holes (shallow pits, not drilled through). This study introduces damping seals of a new type in which the inner surfaces of the stators have sawtooth-cross-section axial grooves interrupted at regular axial intervals by circumferential dams. The teeth of the sawtooth patterns are directed against the rotations in an attempt to reduce further the asymptotic circumferential velocities of the fluids.

Eleven different sawtooth-pattern seals were tested in pumped CBrF_3 (a tire-extinguisher fluid) at various speeds of rotation.

tion and pressure drops in an apparatus instrumented with gauges and probes to measure the dynamic response. For comparison, similar tests were performed on a smooth-surface annular seal and an optimized round-hole-pattern damping seal. The seals were also studied by use of a previously developed turbulent-flow theoretical model that includes the simplifying assumption of directional homogeneity of surface roughness; the author notes that, strictly speaking, this assumption does not apply to the sawtooth seals.

The damping in the sawtooth seals was found to be less than that of the hole-pattern seal but more than that of the smooth seal. The stiffnesses of the sawtooth seals were found to be comparable to that of the hole-pattern seal. Both the sawtooth and the hole-pattern seals leaked less than the smooth seal did. The sawtooth seal that exhibited maximum damping leaked more than the hole-pattern seal did. The theoretically predicted rotordynamic coefficients of the sawtooth seals did not agree well with the measured coefficients.

This work was done by Steven A. Nolan of Texas A&M University for Marshall Space Flight Center. To obtain a copy of the report, "An Experimental and Theoretical Comparison of Rotordynamic Coefficients for Sawtooth-Pattern Damper Seals," Circle 101 on the TSP Request Card.

MFS-27242

Bifurcations in Unsteady Flows

Implications for testing are discussed.

A report discusses the various types of bifurcations that can occur between steady and unsteady aerodynamic flows. It provides examples to illustrate the ways in which bifurcations influence the results of experiments. It recommends that experimenters take bifurcation phenomena into account in the interpretation of measurements.

The bifurcations discussed are mostly those that occur in flows under steady boundary conditions. Such bifurcations include transitions from steady-state, single-valued to steady-state, multiple-valued; to unsteady periodic; to unsteady quasi-periodic; or to chaotic flow. As an example of the first-mentioned type, the coefficient of lift (C_L) of an airfoil might branch from a single value to either of two values at an angle of attack (α) greater than a critical angle. At a bifurcation, the Frechet derivative ($dC_L/d\alpha$ in the example) ceases to exist. The effects of bifurcations on tests that involve unsteady aerodynamics are reviewed by means of examples of both forced and free oscillatory motions. The main observations can be summarized as follows:

The motion of a body can be critical when passing through a bifurcation. The existence of a subcritical bifurcation or a fold can lead to the measurement of a spurious damping if a hysteresis loop is ignored. Motion combined with bifurcation can cause major changes in the characteristics of the aerodynamics, such as those that occur in dynamic stall. Moreover, bifurcations can lead to changes in the characteristics of the motion itself. For example periodic shedding of vortices from an elastically mounted circular cylinder in crossflow can cause the cylinder to undergo a chaotic motion.

These observations lead to the following recommendations concerning the consideration of bifurcation phenomena in experiments involving unsteady aerodynamics: (1) There should be a complete base of testing under static boundary conditions that encompasses all possibilities for the presence of hysteresis. (2) Tests should be conducted in each domain or type of aerodynamics under consideration and across all bifurcation points. (3) The analysis of data must allow for the presence of bifurcations to ensure the proper interpretation of results.

This work was done by Gary T. Chapman and Murray Tobak of Ames Research Center. Further information may be found in NASA TM-1000083 [N88-22014], "Bifurcations in Unsteady Aerodynamics — Implications for Testing."

Copies may be purchased [prepayment required] from the National Technical Information Service, Springfield, Virginia 22161, Telephone No. (703) 487-4650. Rush orders may be placed for an extra fee by calling (800) 336-4700.
ARC-12232

More About Nonobstructive Particle Damping

The concept and its implementation are described in more detail.

A report presents additional information about the engineering concept described in "Nonobstructive Damping for Parts Vibrating in Flows," *NASA Tech Briefs*, Vol. 14, No. 1 (January, 1990), page 61. According to this concept, the vibrations of a structure are damped by powders, balls, or other particles packed and sealed into holes in the structure. The concept is called "nonobstructive particle damping" (NOPD) because it was originally intended as a means to damp vibrations in a vane immersed in a flow of cryogenic liquid without obstructing the flow.

The report implies that NOPD is applicable not only to vanes immersed in flows but also to other vibrating structures. Furthermore, damping fillings could include

not only powders and balls but also slurries or even liquids. According to the generalized version of the NOPD concept presented in the report, the damping holes and fillings are placed in the main load path of a structure, where they help to dissipate vibrations by friction, exchange of momentum, and flexure.

The dimensions and location of the holes and the amount and type of filling are chosen according to parametric and tradeoff design studies. The vibrations of a structure are analyzed initially by finite-element computations, which provide information on frequencies, damping ratios, and the locations of greatest displacement of the various modes of vibration. The results of these computations are correlated with those of experiments as part of a process of optimization. The damping cavities and fillings are designed and placed according to the locations of maximum displacement and the dominant energy-dissipation mechanisms in the mode(s) to be damped.

It is also necessary to analyze stresses and strains in the structure to determine whether any given damping cavity concentrates stresses sufficiently to jeopardize the structure. In a good NOPD design, the overall beneficial effect of the reduction in vibration should be at least sufficient to offset the overall detrimental effect of the concentration of stress.

Provided that the damping fillings are welded or otherwise appropriately sealed in the cavities, the NOPD treatment should last much longer than do more conventional treatments that involve viscoelastic materials, which disintegrate gradually by outgassing and embrittlement. Because the mass of the damping filling is usually less than the mass of the structural material removed to make the damping holes, the NOPD treatment offers the additional advantage of a slight decrease in the weight of the structure. Another advantage of NOPD is that it is largely independent of temperature, pressure, centrifugal force, or other environmental parameters. Yet another advantage is that once the NOPD design has been determined, it is relatively easy to implement because the damping holes can be drilled routinely during fabrication.

This work was done by Hagop V. Panossian of Rockwell International Corp. for Marshall Space Flight Center. To obtain a copy of the report, "Non-Obstructive Particle Damping," Circle 44 on the TSP Request Card.

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act [42 U.S.C. 2457(f)], to Rockwell International Corp. Inquires concerning licenses for its commercial development should be addressed to

Harry B. Field (Patent Counsel)

Rockwell International Corp.

6633 Canoga Avenue

Canoga Park, CA 91304
Refer to MFS-29752, volume and number of this NASA Tech Briefs issue, and the page number.

Finding the Laminar-to-Turbulent Transition

Four methods — including direct visualization — are reviewed.

A technical memorandum evaluates four techniques for determining the location at which laminar flow about an airfoil changes to turbulent flow. The four techniques were studied in flight experiments on an F-14 variable-sweep-wing aircraft.

One of the techniques involves measurements by hot-film anemometer sensors. Because changes in the boundary-layer flow change the cooling effect of the flow on the heated active elements of the sensors, the outputs of the anemometers provide indications of the flow conditions.

Another technique involves measurements by boundary-layer rakes, each an array of pressure probes. The pressures at the probes are sampled electronically in sequence to obtain a map of pressure (and velocity) over the airfoil.

In the third technique, measurements are taken by pitot tubes arrayed on the airfoil, flush with its surface. The pressures sensed by the pitot tubes are also sampled in sequence electronically.

In the fourth technique, the test airfoil surface is coated with pressure-sensitive liquid crystals, to make the pressure pattern of the flow visible. The liquid crystals change color at the boundary-layer transition. The airfoil is photographed in flight from a chasing airplane.

In the F-14 experiment, measurements by the hot-film anemometers proved to give the most accurate indication of the laminar-to-turbulent transition. The anemometer data, obtained at 10 percent chord increments, were found to be accurate within ± 2.5 percent. The sensors would have to be more closely spaced, however, to define the entire transition region.

The measurements taken by the boundary-layer rakes were found to be good secondary indications of the location of the transition. The data from the boundary-layer rakes agreed within ± 5 percent with those from hot-film anemometers. Boundary-layer rakes have an added advantage: they also provide data on parameters related to skin friction.

The measurements taken by the surface pitot tubes did not consistently indicate the location of the transition. Often, the data indicated two such locations. The first location generally agreed with that indicated by the hot-film-anemometer data at lower altitudes, while the second location agreed with that indicated by the hot-

film-anemometer data at higher altitudes.

The liquid-crystal coat was found to be useful for the visualization of the flow: it gives a global picture of the location of the transition, unlike the other techniques, which are limited to sampling at discrete points on the transition. Only a camera is needed for documentation. One of the minor disadvantages of the liquid-crystal technique is that dust and insects tend to adhere to the coat, producing localized turbulence. Another disadvantage is that unevenness in the thickness of the coat causes changes in color, interfering with the interpretation of the color pattern.

This work was done by Bianca T. Anderson, Robert R. Meyer, Jr., and Harry R. Chiles of Ames Research Center. Further information may be found in NASA TM-100444 [N88-30093], "Techniques Used in the F-14 Variable-Sweep Transition Flight Experiment."

Copies may be purchased [prepayment required] from the National Technical Information Service, Springfield, Virginia 22161, Telephone No. (703)487-4650. Rush orders may be placed for an extra fee by calling (800) 336-4700. ARC-12390

An Implementation of the Solution-Adaptive-Grid Method

The formulation of the method and instructions for use of a computer code are presented.

A NASA technical memorandum discusses the solution-adaptive-grid method and the Self Adaptive Grid Evolution (SAGE) computer code, which implements the method. This particular adaptive-grid method, described in more detail in a previous issue of *NASA Tech Briefs*, provides for redistribution of points in grids used to compute flows — especially supersonic and hypersonic flows that contain shocks, and other strong gradient regions, discontinuities, and shear layers. It is necessary to redistribute the grid points because frequently the initial choice of a computational grid does not capture the flow structures well enough to yield an accurate solution. The redistribution of points (the adaptation of the grid) is performed on the basis of the flow solution obtained on the initial grid, then the flow is recomputed on the adapted grid.

The document is divided into three parts. The first part presents a formulation of the method for a two-dimensional flow. The adaptation concept is based in part on a version of the variational principle of mechanics. The adaptation procedure is analogous to applying, at each grid point, tension and torsion spring forces proportional to the local flow gradient computed on the initial grid, then finding the equilibrium con-

figuration into which the spring forces distort the grid. The tension springs redistribute greater numbers of grid points into regions of strong flow gradients; the torsion springs relate information between adjacent lines in such a way as to keep the lines as nearly smooth and the grid as nearly orthogonal as possible.

The adaptation of a two-dimensional grid is performed as a sequence of two one-dimensional adaptations — marching along the first coordinate while adapting the second coordinate, then marching along the second coordinate while adapting the first coordinate. It is important to point out that the result of this adaptation is not unique; nor is it an exact solution to the variational problem because it depends on which coordinate is adapted first and on the directions of marching along both coordinates. However, the nonuniqueness of the adapted grid is acceptable because it reduces errors in the flow computed on the grid.

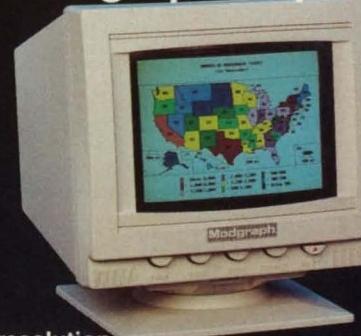
The second part of the report presents instructions for the use of the SAGE computer code. This part does not require detailed knowledge of the mathematical concepts explained in the first part and can be read as an independent document. It includes a detailed description of the input control parameters (including the user's specification of the sequence of coordinates and directions of marching), descriptions of computing routines, nomenclature, and other information needed to run the code. Stated briefly, the code reads three input data files: one that contains the coordinates of the initial grid, another that contains the flow-field variables computed on the initial grid, and a third that contains the input-control parameters. The code then adapts the grid to the flow field according to the principles described in the first part of the report.

The third part of the report contains several examples to familiarize the user with the adaptive-grid process. Each example includes plots of the initial grid and flow-field contours, the control parameters used in the adaptation, the adapted grid, and a discussion of the choice of the control parameters. The examples are supersonic flow in an inlet, hypersonic flow about a blunt body, impingement of a shock on a blunt body, hypersonic flow in an inlet, and flow in an axisymmetric plume.

This work was done by Carol B. Davies and Ethiraj Venkatapathy of Ames Research Center. Further information may be found in NASA TM-102198 [N90-12211], "A Simplified Self-Adaptive Grid Method, SAGE."

Copies may be purchased [prepayment required] from the National Technical Information Service, Springfield, Virginia 22161, Telephone No. (703) 487-4650. Rush orders may be placed for an extra fee by calling (800) 336-4700. ARC-12736

The Modgraph Super-VGA Monitors



- 8.5" Display
- 800x600 Resolution
- Sony Trinitron CRT
- .26mm Dot Pitch
- Open Chassis or
- Full Enclosure

For high resolution graphics and data applications, these Super-VGA display monitors offer the OEM, System Integrator, and end-user a high quality Trinitron-based display in a compact package. Offered in industrial, open frame, or desktop tilt and swivel enclosures, these monitors are designed to meet size and weight sensitive applications. Call 1-800-327-9962 for further information.



Modgraph

83 Second Avenue
Burlington, MA 01803

DEALER/OEM/VAR
Inquiries Invited

Circle Reader Action No. 435

Introducing the TransItainer COST-EFFECTIVE WAY TO SHIP ELECTRONICS



- Rugged, reusable, stackable
- Tough Roto-molded, color-impregnated plastic
- Meets ATA 300, Category 1, and MIL-SPEC
- Gasketed, weather-tight
- Wide range of sizes — 6" x 6" to 48" x 52"
- Available from inventory in 1 to 2 weeks
- 127 field reps for at-your-site custom design
- Call today for technical details and our case catalog

ZERO PLASTICS
UNIT OF ZERO CORPORATION

672 Fuller Road, Chicopee, MA 01020

PHONE: (413) 267-5561
FAX: (413) 592-5018

Circle Reader Action No. 614



Machinery

Hardware, Techniques, and Processes

66 Oblique-Flying-Wing
Supersonic Transport
Airplane

66 Two-Axis Track Rollers

Books and Reports
67 Lifting Loads With
Two Helicopters

Oblique-Flying-Wing Supersonic Transport Airplane

A previously abandoned design concept is reintroduced.

Ames Research Center, Moffett Field, California

An oblique-flying-wing supersonic airplane for the transport of passengers and cargo has been proposed as a possible alternative to the B747B (or equivalent). The oblique-flying-wing concept was first proposed in 1957 by Dr. R. T. Jones but was abandoned because of then-insoluble problems of stability and control. Since that time, the technology of artificial stabilization has advanced sufficiently to warrant reintroduction of the concept.

In the baseline configuration (see figure), the airplane would accommodate 462 passengers and 16 cabin crewmembers. The interior would resemble that of a wide-body aircraft, with an average aisle height of 1.91 m. Windows would be installed in the leading edge, and emergency exits would be located in the leading- and trailing-edge sides of the passenger cabin. The cockpit would be located at left end of the cabin for a pilot and a copilot. The pilot would have good visibility during approach and climb.

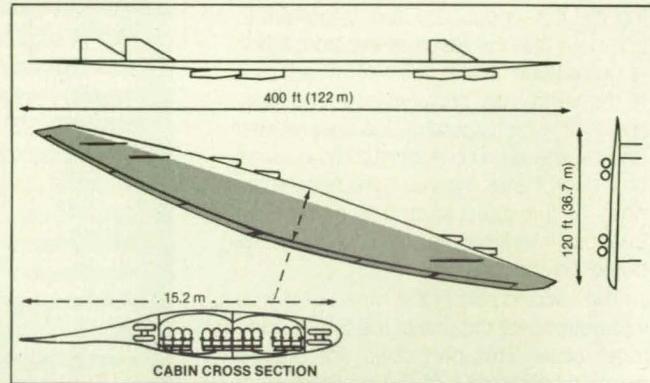
The wing would have an elliptic planform with a nearly elliptic spanwise thickness-to-chord distribution, resulting in minimum wave drag for a given volume. The wing would be curved upward slightly to obtain an elliptic spanwise lift distribution. The wing can be swept from 35° at takeoff to 72° in cruise to achieve the maximum lift-to-drag ratio for any speed from mach 0.2 to mach 2.0. To achieve the required lift with minimal drag and a nearly level cabin floor, during cruise, the center of gravity would be shifted to the required position by a fuel trim system. The airplane would have a conventional monocoque and honeycomb structure incorporating the aluminum alloy

The **Oblique Flying Wing** would transport passengers and cargo as fast as twice the speed of sound at the same cost as current subsonic transports. It could fly at the same holding speeds as those of present supersonic transports but require only half the takeoff distance.

RR.58-AU2GN (or equivalent) developed for the Concorde. By limiting the speed to mach 2, one would reduce the equilibrium skin temperature from 130°C to 100°C, thereby increasing the life of the airframe over that of the Concorde.

To increase yaw control in case of the failure of one engine and to minimize the wave drag and wing stress, the engines would be podded in four nacelles. The nacelles could be pivoted over a 35° range and would be distributed optimally along the span. In view of the limitations of the artificial-stability-and-control system, the nacelles would have to be placed as far forward as possible. Four 250-kN engines of conventional design would be used. The undercarriage would include six legs with four tires each.

The maximum takeoff weight would be 20 percent less than that of the B747. The aircraft would operate from conventional runways within the FAR 36 stage 3 noise requirements. The oblique-flying wing can also operate overland at the boomless supersonic cruise mach number of 1.2. Stability and control around the roll and pitch



axes would be provided by a 10-percent multisectioned trailing-edge flap. Segmenting the trailing-edge flap would increase the reliability of the system and enable the control of roll. Such a flap system could help to smooth out any gusts and allow the use of a more-cambered wing and a higher design lift. The artificial-stability-and-control system for this flap would include a standard proportional/integral/derivative controller that would relate the angle of pitch and its first and second derivatives with respect to time to an optimum flap deflection.

This work was done by Alexander J. M. Van der Velden of Stanford University for Ames Research Center. Further information may be found in NASA CR-177529 [N89-25233], "The Conceptual Design of a Mach 2 Oblique Flying Wing Supersonic Transport."

Copies may be purchased [prepayment required] from the National Technical Information Service, Springfield, Virginia 22161, Telephone No. (703) 487-4650. Rush orders may be placed for an extra fee by calling (800) 336-4700.
ARC-12525

Two-Axis Track Rollers

A compact, lightweight design would reduce side friction.

Marshall Space Flight Center, Alabama

A set of proposed two-axis track rollers would enable a sliding door to follow a curved track in both directions without binding. The rollers are intended for use on sliding hatch covers on the proposed Space Station Freedom and would probably also

be useful on Earth to ensure ease and reliability of motion in sliding doors, windows, covers, and partitions.

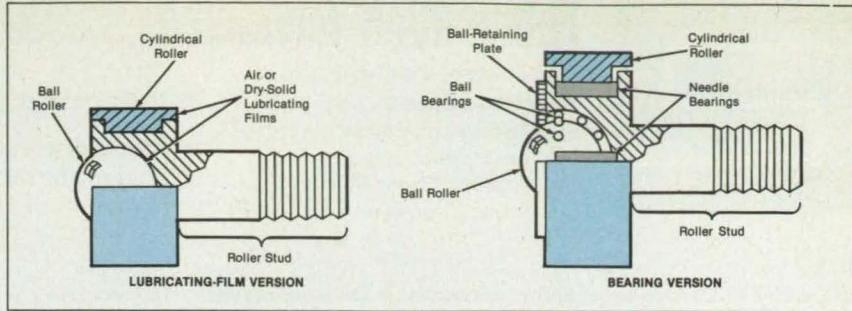
The basic problem is to design a light-weight, compact roller that can follow a track similar to that on a sliding garage

door, without binding. In the formulation of this design, any device used to reduce the side friction that causes binding must not, itself, cause binding. In the intended Space-Station application, the design of the rollers would also affect the design of

a switching mechanism that would control the paths of the rollers along the track. Two previous solutions were tried and rejected:

1. A combination of three rollers mounted on a pivoting track: Two of the rollers would follow the track while the third, placed between the other two, would keep the other two from binding on the inside of the web of the track; the whole assembly would pivot to accommodate the curves in the track. This mechanism would be bulky and heavy and would necessitate both a track that is larger and a switching mechanism that is more complicated than are those envisioned for the initial application.
2. An assembly including a cam follower with a ball transfer attached to its end: This design required a track of excessive depth.

The proposed two-axis track roller evolved from the second of the rejected designs. It would be essentially a roller of the cam-follower type, with a large ball embedded in its end to minimize side friction on the roller. In the version illustrated on the left side of the figure, the roller would



The Two-Axis Track Roller would be a combination of a cylindrical cam-follower-type roller and a large ball end roller.

incorporate an air or a dry-solid lubricating film. The version illustrated on the right side of the figure would incorporate needle and roller bearings. An alternative version might incorporate some combination of film lubricant(s), needle bearings, and/or roller bearings. The choice of combination is not critical, though a dry-film design would tend to be the most compact and lightweight. A suitable dry lubricant might be Karon (or equivalent), which is being

considered for use in outer space.

This work was done by John M. Melinick and Kenneth O. Juebschman of Boeing Aerospace & Electronics for Marshall Space Flight Center. No further documentation is available.

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Marshall Space Flight Center [see page 14]. Refer to MFS-28470.

Books and Reports

These reports, studies, handbooks are available from NASA as Technical Support Packages (TSP's) when a Request Card number is cited; otherwise they are available from the National Technical Information Service.

Lifting Loads With Two Helicopters

Force-balance equations serve as a basis for coordination in flight.

A report discusses the theoretical equilibrium characteristics of a dual-helicopter lifting system. Such systems have been employed in both the military and civilian sectors to deliver weapons, vehicles, and construction materials. However, dual-helicopter lifts have not been optimized with respect to consumption of fuel by the helicopters, stability, maneuverability, and other critical operating characteristics. The analysis presented in the report provides the mathematical basis for the selection of lifting configurations and flight parameters.

In the system under study, the cargo is suspended by two cables, one attached to each end of a spreader bar. Each end of the spreader bar is suspended by a tether cable from one of the helicopters. The analysis is based on the application of the force-balance equations to the centers of gravity of the load and helicopters and to the endpoints of the spreader bar.

The analysis is simplified. It does not consider the degrees of freedom of the attitudes of the load and helicopters but,

rather, assumes that these attitudes are stable. The analysis also assumes that the aerodynamic forces on these bodies are independently calculable as functions of the trajectory of the system or that they can be measured in flight. These simplifications make it possible to solve the force-balance equations in closed form, with the equilibrium aerodynamic forces appearing parametrically.

The results of the analysis are given for the angles of orientation of the components; for the internal forces of the system; and for the required helicopter thrusts (for identical or nonidentical helicopters) under any static or accelerating but otherwise equilibrium flight condition, any orientation of the system relative to the direction of flight, and any distribution of the load between the two helicopters. Optimum tether angles that minimize the sum of the required thrust magnitudes are also determined. These results can be applied to coordinate the system in flight.

A given system can have many equilibrium orientations, with three angles that can be selected by the pilot or autopilot: (1) the formation angle (the heading of the spreader bar relative to the ground-track direction), (2) the tilt of the spreader bar relative to the apparent gravitation of the suspended load (including the aerodynamic forces), and (3) the tilt of one of the tethers relative to the spreader bar. The analysis shows that the required thrusts vary strongly with the tether angle but are nearly invariant with respect to the other

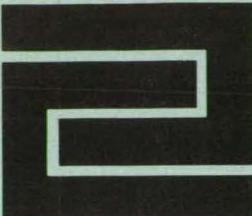
angles. Consequently, the tether angle can be selected to minimize the sum of the required thrusts. This choice not only maximizes the margin of safety of available thrust but also minimizes the rate of consumption of fuel in the case of identical helicopters.

The tilt of the spreader bar controls the distribution of the load to the two helicopters. The analysis shows that, in general, the tilt can be selected for any distribution for which all cables remain under tension and for which both helicopters have margins of safety of thrust. The load can always be distributed in such a way that the thrusts required of the helicopters are proportional to their maximum available thrusts.

The formation angle can be set at a fixed value as in conventional formation flying. However, with automatic flight control, it may be possible to vary the formation angle during flight.

This work was done by L. S. Cicolani and G. Kanning of Ames Research Center. Further information may be found in NASA TP-2615 [N88-19407], "General Equilibrium Characteristics of a Dual-Lift Helicopter System."

Copies may be purchased [prepayment required] from the National Technical Information Service, Springfield, Virginia 22161, Telephone No. (703) 487-4650. Rush orders may be placed for an extra fee by calling (800) 336-4700.
ARC-11812



Fabrication Technology

Hardware, Techniques, and Processes

- 68 Tomographic Measurement of Laser-Bored Holes
69 Improved Warm-Working Process for an Iron-Base Alloy

- 69 High-Pressure Lead-Through Joint
70 Platable Filler and Sealant
71 Thread-Pull Test of Curing Adhesive

- 72 Simulating Welding-Robot Trajectories for Previewing Books and Reports
73 Gas Contamination in Plasma-Arc-Welded Aluminum
73 Moving and Working on Space Structures

Tomographic Measurement of Laser-Bored Holes

A nondestructive technique detects internal variations in arrays of small holes.

Marshall Space Flight Center, Alabama

An inspection method checks laser-bored holes for accuracy. The method combines computed tomography and digital laminography.

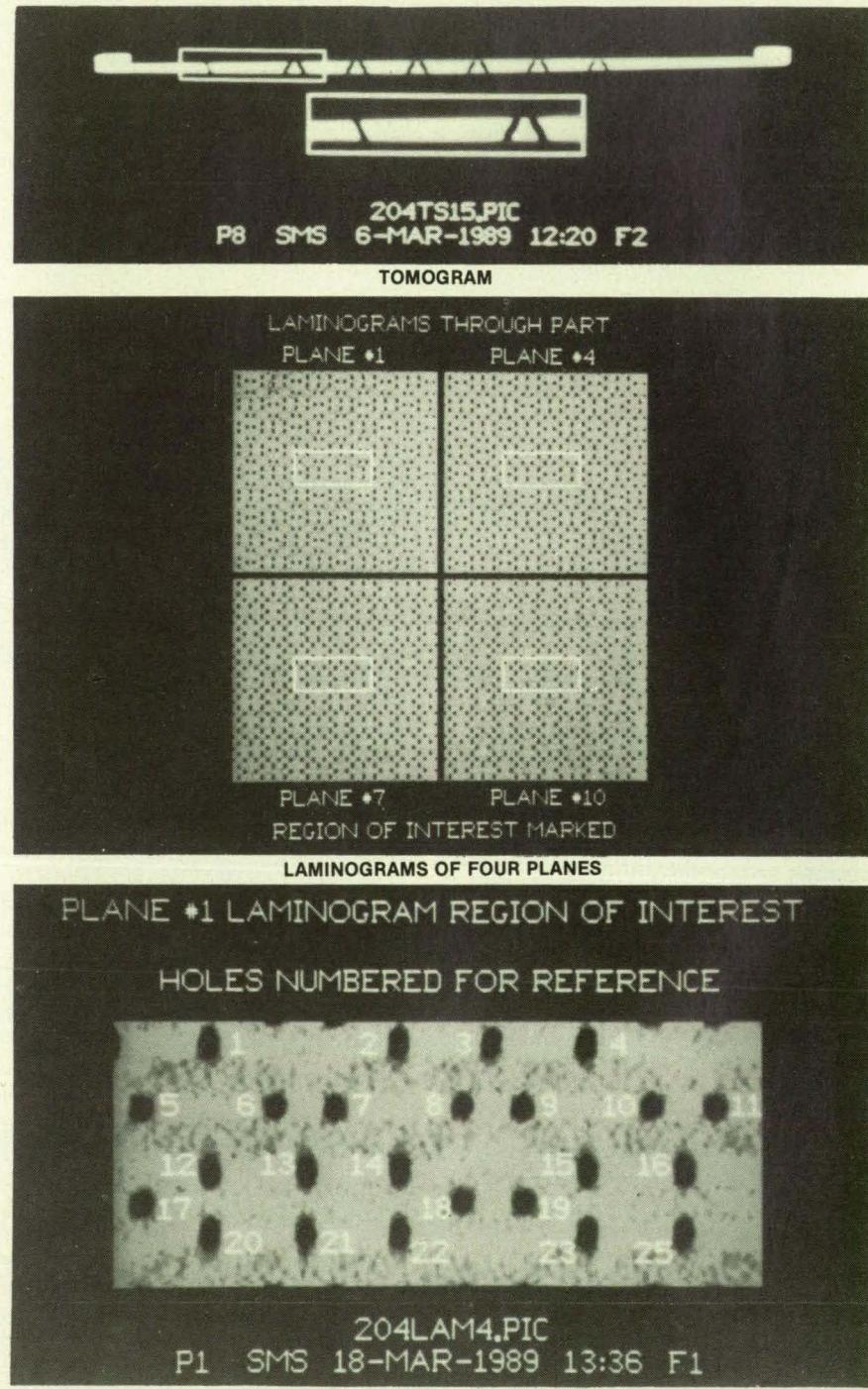
The usual methods of inspecting narrow holes are not suitable for those made by laser. For example, the insertion of a wire gauge into a hole yields only crude information on the direction and size; it cannot detect the internal changes that occur with laser boring. Moreover, the insertion of wires is time consuming and subject to error from subjective biases and variations in the inspector's touch and feel.

In the new method, a plate containing an array of laser-bored holes is scanned by a high-resolution x-ray system that generates both tomographic views and digital laminograms (see figure). The tomographic views are transverse cross sections that show the axial geometries of the holes. The laminograms are longitudinal cross sections that show the radial geometries of the holes. Both types of views are made at many parallel planes within the plate. The system also prints out tables of measured and standard deviation of diameter at all planes for each hole.

This work was done by James D. Willenberg, Jack Roy, and Lyle B. Spiegel of Rockwell International Corp. for Marshall Space Flight Center. For further information, Circle 153 on the TSP Request Card.

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Marshall Space Flight Center [see page 14]. Refer to MFS-29770.

Internal Nonuniformity is clear in a computed tomographic axial view of laser-bored holes (top). Variations of shape and dimensions among holes appear in laminograms (center), especially in the closeup of a region of interest. The holes in these pictures are nominally about 0.025 in. (0.64 mm) in diameter.



MAGNIFIED VIEW OF REGION OF INTEREST IN LAMINOGRAM OF PLANE 1

Improved Warm-Working Process for an Iron-Base Alloy

Forgings are stronger than those produced by the prior warm-working process.

Marshall Space Flight Center, Alabama

A warm-working process produces a predominantly unrecrystallized grain structure in forgings of the iron-base alloy A286 (PWA 1052 composition). As a result, the yield strength and ultimate strength are increased, and the elongation and reduction of area at break are decreased. The improved process can be used on forgings up to 10 in. (25 cm) thick and weighing up to 900 lb (408 kg). This process is a refined version of the previous warm-working process (see figure), which could handle only plates no thicker than 0.5 in. (about 1.3 cm).

Unusual features of the improved process include the following:

- The inclusion of a recrystallization cycle before the final warm-working operations;
- Warm working in steps when necessary, with progressively cooler reheating;
- Limiting the maximum forging rate; and
- The definition of a properly processed microstructure.

These features help to ensure that the predominantly unrecrystallized structure is formed. Such a structure is necessary to obtain strength significantly greater than that of conventionally processed material. These features of the improved process also help to maintain the structure by inhibiting development of dynamic recrystallization, which would reduce tensile strength.

In a representative procedure, a starting billet 12.5 in. (32 cm) in diameter and 18

	TEMPERATURES (°F) FOR STAGES OF THREE PROCESSES		
	Conventional Process	Prior Warm-Working Process (U.S. Patent 3,708,353)	Improved Warm-Working Process
Final Deformation Cycles	1,800 to 2,000	1,550 to 1,800	1,500 to 1,700
Solution Heat Treatment	1,750 to 1,800	—	—
Stabilization Heat Treatment	—	1,400 to 1,500	—
Precipitation Heat Treatment	1,325	1,300	1,200 to 1,300

The Improved Warm-Working Process involves, among other things, slightly lower temperatures.

in. (46 cm) tall is first thermally recrystallized at 1,900 °F (1,038 °C), then cooled to below 1,000 °F (538 °C). The billet is then heated to 1,600 °F (871 °C), followed by a 40-percent upset cool to below 1,200 °F (648 °C). Then the billet is heated to 1,500 °F (816 °C) and forged, followed by a 30-percent upset water quench. Forging is done at an average rate no greater than 2 in./s (5 cm/s).

Test specimens from billets forged in this way and in the conventional way had the following properties:

- 0.2-percent-yield strength: 144 to 156 ksi (993 to 1,076 MPa) versus 100 ksi (689 MPa) for the conventionally processed specimen.
- Ultimate strength: 172 to 183 ksi (1,186 to 1,261 MPa) versus 160 ksi (1,103 MPa)

for the conventionally processed specimen.

- Elongation at break: 11 to 13 percent versus 22 percent for the conventionally processed specimen.
- Reduction in area at break: 20 to 25 percent versus 40 percent for the conventionally processed specimen.

This work was done by Fred P. Cone, Brendan J. Cryns, John A. Miller, and Robert Zanoni of United Technologies Corp. for Marshall Space Flight Center. No further documentation is available.

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Marshall Space Flight Center [see page 14]. Refer to MFS-28503.

High-Pressure Lead-Through Joint

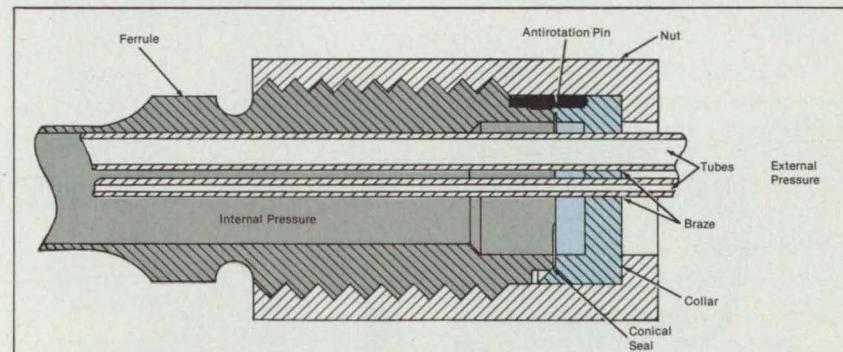
A simple joint forms a tight seal without washers or O-rings.

Marshall Space Flight Center, Alabama

An improved ferrule-type joint carries multiple tubes for probes and wires into a pressure vessel. The joint can readily be installed and removed without damage to the tubes. It forms a virtually leakproof seal and can withstand extreme operating environments.

A typical conventional ferrule-type lead-through joint includes a washerlike blob of sealing material that has to be compressed by applying a high torque to a nut. The sealing material must be carefully selected to suit the operating conditions. In another type of conventional lead-through joint, tubes must be brazed in place for assembly (and unbrazed in place for disassembly), and the brazing heat can damage surrounding materials.

The improved ferrule-type joint includes a ferrule on which a nut holds a collar that contains the tubes (see figure). The tubes



The High-Pressure Joint consists of four parts: ferrule, collar, antirotation pin, and nut. The collar is easily removed and replaced. Tubes are brazed to the collar before the joint is assembled on the pressure vessel.

are inserted into predrilled holes in the collar and brazed to it before assembly. The brazing is done before assembling the joint because the brazing heat could damage

the ferrule and possibly other components of the joint.

The probes and wires (if any) are threaded through the tubes. The collar is inserted

in the ferrule along with a pin that fits in axial slots in the collar and ferrule to prevent the collar from rotating in the ferrule and thereby twisting the tubes. The nut is then tightened over the collar, forcing the internally chamfered edge of the collar axially against the ferrule end to form a conical seal.

When the pressure in the vessel is greater than the pressure outside, the pressure assists the seal by adding to the axial

force of the ferrule against the collar. Consequently, a low tightening torque on the nut is adequate. However, even when the pressure inside is greater than the external pressure, less torque is needed than in a conventional seal because there is no need to compress a blob of sealing material.

The collar and tubes can be removed simply by unscrewing the nut. If it is necessary to separate the brazed tubes from

the collar, heat can be applied to it after it has been removed from the ferrule so that the ferrule and other components of the joint do not have to be exposed to heat.

This work was done by Patrick B. Melton of United Technologies Corp. for Marshall Space Flight Center. For further information, Circle 10 on the TSP Request Card. MFS-28404

Platable Filler and Sealant

An easy-to-use material resists heat and chemicals.

HIGH SPEED PHOTOGRAPHY

At major test facilities nationwide, High Speed Photography is synonymous with the Photo-Sonics 16mm-1PL Camera.

And for good reason. Rock-steady pictures from 10 to 500 pin-registered frames-per-second! Quick-change 200', 400' and 1200' film magazines. Multiple camera synchronous phase lock operation. Built-in numeric or BCD data recording, automatic exposure control...and more.

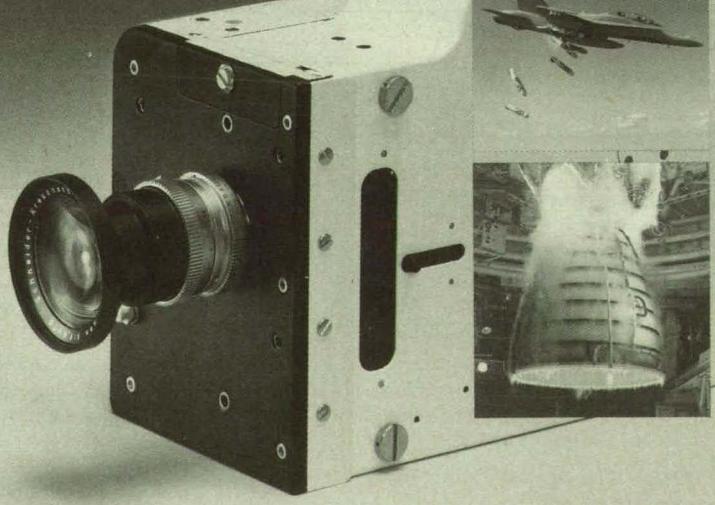
These features and an unequalled reliability record in harsh airborne or ground environments make the 1PL the clear choice for high speed photo analysis. Contact us for detailed technical data and complete test results.

Phone
213-849-6251

Fax
818-842-2610



820 S. Mariposa St.
Burbank, CA 91506



Marshall Space Flight Center,
Alabama

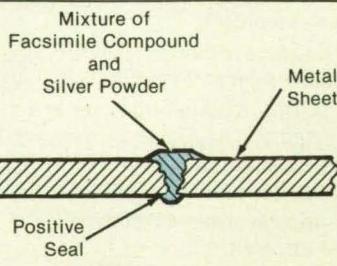
A mixture of a commercial molding ("facsimile") compound and silver powder is used in the repair of small holes in metal. The facsimile compound is used to fill the holes. The silver powder makes the filling electrically conductive, so that the repair can be electroplated to make a smooth, continuous surface.

The mixture is first applied to the hole and smoothed over. The silver additive slows the curing process somewhat; the facsimile compound normally cures in 6 to 8 minutes, but the additive prolongs the cure to 30 to 45 minutes. Nickel, copper, or other metal can be electrodeposited on the cured material.

The compound does not deteriorate in high plating-bath temperatures, unlike wax and other fillers. It provides a surface to which plated metals can readily adhere. Moreover, if plating is not completely successful and the plated layer must be removed, the compound is not adversely affected by stripping solutions.

This work was done by Todd R. Heerman and Jerome G. Volkenant of Rockwell International Corp. for Marshall Space Flight Center. For further information, Circle 133 on the TSP Request Card.

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Marshall Space Flight Center [see page 14]. Refer to MFS-29735.



A Mixture of Facsimile Compound and Silver powder forms a positive seal in a small hole in a metal sheet. The filled hole can be plated over by standard electrodeposition.

Thread-Pull Test of Curing Adhesive

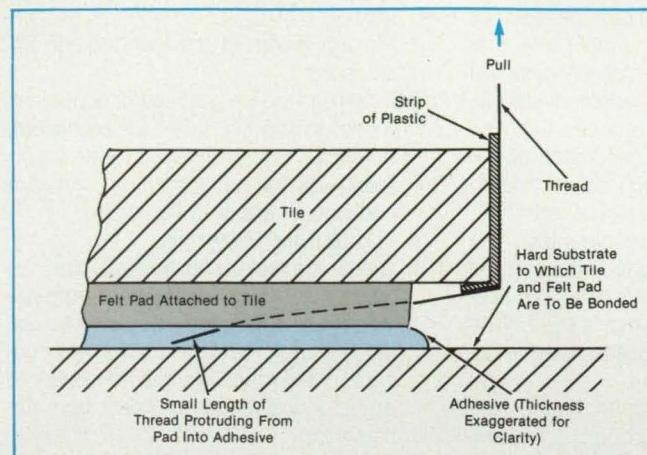
The force required to withdraw a thread indicates the degree of cure.

Lyndon B. Johnson Space Center, Houston, Texas

A test indicates whether an adhesive layer has attained the proper degree of cure. In the test, one measures the force required to withdraw a thread embedded in the adhesive. The test can be used, for example, where a soft, penetrable material like felt is bonded to a similar material or to a hard substrate like aluminum or ceramic.

In one version of the test, a Nomex (or equivalent) polyamide thread, 0.006 in. (0.15 mm) in diameter, is inserted through a felt pad attached to a ceramic tile that is to be bonded to a hard substrate by use of room-temperature-vulcanizing silicone rubber. The thread is drawn through the pad with a needle so that it protrudes from the pad at approximately the center of the area to be bonded, where curing is likely to be slowest.

After the required curing time, the thread is pulled out of the assembly. (A thin, removable strip of plastic could be used to protect the side of the assembly from the pulled thread.) The force required to remove the thread has been found to be approximately proportional to the hardness



Hardness (and Degree of Cure) of an adhesive layer is measured by pulling a previously inserted thread out of the layer. The strength of the bond is measured directly on the assembly rather than on samples, which can be misleading.

of the adhesive layer and thus indicates the extent of the cure.

Any thread material suitable to a particular application can be used, but a force-vs.-hardness calibration curve must first be established for the particular combination of thread and adhesive. Several threads can be inserted at different positions in the assembly, then removed individually to

trace the progress of the cure. Because the withdrawal of a thread leaves only a small void, the test should have little, if any, adverse effect on the strength of the bond.

This work was done by James A. Johnson of Rockwell International Corp. for Johnson Space Center. For further information, Circle 106 on the TSP Request Card. MSC-21782



Numerical Algorithms Group

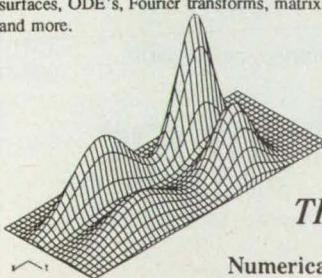
If your applications require mathematical programming, you can learn what users the world over have discovered. The NAG Numerical Libraries or other software products allow you to spend your time and talents on genuine problem solving, not software development. Your code will be more portable, your results will be more reliable - all in considerably less time. Take advantage of NAG's expertise in any of these fine products:

NAG Fortran Library

A flexible tool for building custom mathematical applications, includes more than 900 user callable subroutines frequently required for scientific or engineering projects.

Resolution

A powerful Mac-based mathematical tool box with a graphical user interface designed to mimic a scientific calculator. Provides point and click analysis for 3-D surfaces, ODE's, Fourier transforms, matrix calculations and more.

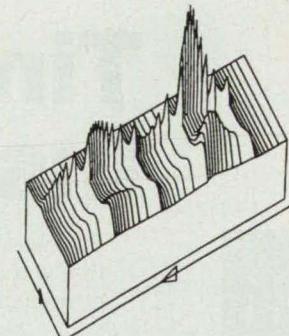


NAG C Library

NAG's expertise in mathematics is now available in a subroutine library developed entirely in C. Using just one of the many routines can easily offset the cost of writing your own algorithms.

NAGware F90 Compiler

A true multipass Fortran 90 compiler. Compiles Fortran 90 code to C. Allows the Fortran user to take immediate advantage of the full features of Fortran 90. Available for a number of UNIX machines.



Symbolic Algebra Software

NAG markets several symbolic algebra software products. If your work requires powerful algebraic manipulation turn to NAG for features and facilities not available in other packages.

NAG VecPar_77

An interactive CASE tool for vectorizing and parallelizing Fortran programs. Attain performance improvements beyond what optimizing compilers may provide. Ideal for "rejuvenating" older applications.

For complete details, write NAG or call 708/971-2337.

THE SCIENTIFIC AND NUMERICAL SOFTWARE SPECIALISTS

Numerical Algorithms Group Inc., 1400 Opus Place, Suite 200, Downers Grove, IL 60515-5702 USA Tel: 708/971-2337

Simulating Welding-Robot Trajectories for Previewing

Simulation time and errors are reduced.

Marshall Space Flight Center, Alabama

A new method has been devised for generating those welding-tool paths that are parts of the off-line-programmed test trajectories of a computer-controlled welding robot. The method reduces the time necessary to set up a simulation of the welding process and eliminates some errors by reducing the amount of repetition. Throughout the process of generating the trajectory of the welding tool, the method provides visual feedback similar to that of the graphical simulation that is used in the off-line-programming process after the development of a model.

The method is applicable to the Unigraphics (or equivalent) computer-aided-design software and relies, in part, on the availability of a MicroVAX (or equivalent) computer. The new method is best understood in the context of the old method, which is summarized as follows:

1. Transfer the three-dimensional computer-aided-design model to the Unigraphics (or equivalent) computer-aided-design software, and add "go to" points. File the

- model.
2. Make a sketch of the tool and "go to" locations.
3. Download the Unigraphics (or equivalent) model to the MicroVAX (or equivalent) computer, and use PLACE (or an equivalent) off-line-programming software package to create a vector file.
4. Print out the vector file.
5. Create the tool-verification-trajectory file by manually entering the data from the vector file. (There are nine sets of numbers for each vector.) If a typing error occurs midway through, it is necessary to go back and reenter the data from the beginning.

The new method consists of the following steps:

1. Transfer the three three-dimensional computer-aided-design model to the Unigraphics (or equivalent) software.
2. Create the tool "go to" points by use of the Unigraphics (or equivalent) manufacturing software module. The operator sees both a three-dimensional computer-

aided-design model of a tool and a three-dimensional torch moving along the tool path. The operator can accept or reject and redefine each "go to" point as it is created. The resulting file, which contains the "go to" points, is downloaded to the MicroVAX (or equivalent) computer.

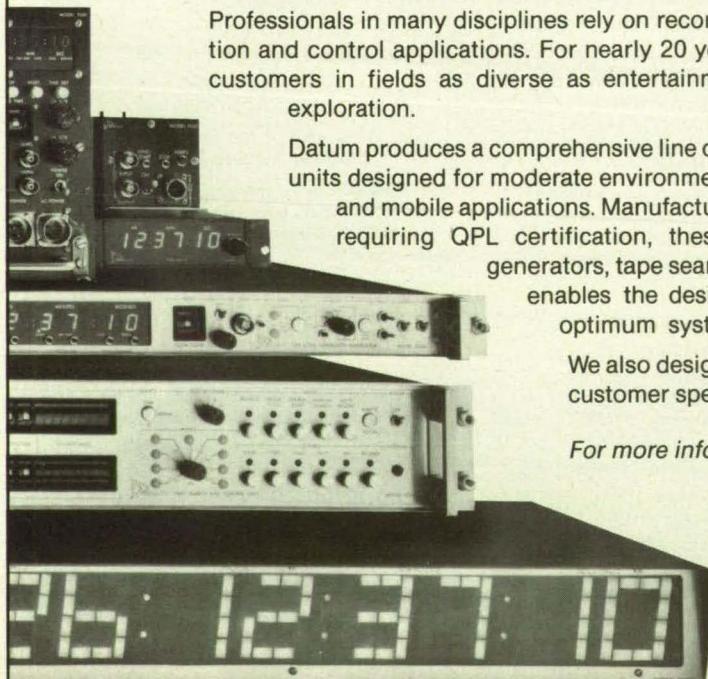
3. Execution of the program "CLART2PAR" (or equivalent) automatically converts the "go to" file to the trajectory file used to verify the programming of the robotic welding tool. This program takes 5 to 15 seconds to run.

This work was done by Maureen L. Levitt and Karen E. Sliwinski of Rockwell International Corp. for Marshall Space Flight Center. No further documentation is available.

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Marshall Space Flight Center [see page 14]. Refer to MFS-29747.

Time Code Instrumentation

MANY ITEMS ON GSA!



Professionals in many disciplines rely on recorded time code as a primary reference in data correlation and control applications. For nearly 20 years we've supplied quality timing instrumentation to customers in fields as diverse as entertainment, medical research, flight test and deep space exploration.

Datum produces a comprehensive line of timing instrumentation products, from rack mounted units designed for moderate environments, to ruggedized equipment for airborne, shipboard and mobile applications. Manufactured to commercial standards or military specifications requiring QPL certification, these instruments include time code translators and generators, tape search units, digital clocks and displays. A host of options enables the designer to maintain cost effectiveness while achieving optimum system configuration.

We also design and manufacture complete range timing systems to customer specifications.

For more information or applications assistance, call or write.

DATUM INC
Timing Division

1363 S. State College Blvd., Anaheim, CA 92806-5790
(714) 533-6333

Books and Reports

These reports, studies, handbooks are available from NASA as Technical Support Packages (TSP's) when a Request Card number is cited; otherwise they are available from the National Technical Information Service.

Gas Contamination in Plasma-Arc-Welded Aluminum

Contaminated welds can easily be identified visually.

A document describes an experimental investigation on the visible and tactile effects of gaseous contaminants in variable-polarity plasma arc (VPPA) welding of 2219 T-87 aluminum alloy. There are many possible sources of contamination in VPPA welding, including contaminated gas bottles, leaks in gas plumbing, inadequate flow of the shielding gas, condensed moisture in the gas tubes or the body of the torch, and excessive contaminants on the workpiece. It is particularly important to avoid such contamination in VPPA welding for several reasons:

- The large area of contact between the gas and the workpiece favors the absorption of impurities in the weld pool.
- The small weld pool that is characteristic of VPPA welding can easily become supersaturated with such impurity gases as hydrogen, which cause porosity when the pool solidifies.
- Gases active on the surface of the weld pool can alter flow patterns, causing undercutting and other defects.
- The high speed of VPPA welding allows little time for absorbed impurities to effervesce from the weld pool.

In the investigation, contaminant gases (nitrogen, methane, oxygen, and hydrogen) were introduced in the argon arc and in the helium shield gas in various controlled concentrations. The report presents the results of the experiments in the form of photographs of the fronts, backs, polished cross sections, and etched cross sections of welds made with various contaminants at various concentrations. It provides a detailed discussion of the conditions under which the welds were made.

The document also verbally describes the appearances of welds to guide the welder in identifying the presence and type of contamination. It suggests that the welder look for the following:

- A smooth, almost-ripple-free keyhole pass. The cover pass should show even less rippling. Increased rippling on the front surface is one of the first indications of all impurities except oxygen.
- Fine, regularly spaced ridges on the back

side of the weld. When the finger is run along the back side, the welder should feel the ridges, but no sharp crests. Oxygen can be detected readily by feeling a significantly rougher back side.

- The ridges on the back side should be perpendicular to the direction of the weld. Slanting of these ridges is an indication of undercutting.
- A dull, matte appearance on the front side.
- At most, only slight granular extrusions on the edges of the weld bead and none on the bead. Noticeable granular extrusions on the bead and moderate extrusions on the edges indicate contamination by methane.

This work was done by John C. McClure, Martin R. Torres, Alan C. Gurevitch, and Robert A. Newman of the University of Texas at El Paso for **Marshall Space Flight Center**. To obtain a copy of the report, "The Effect of Impurity Gases on Plasma Arc Welded 2219 Aluminum," Circle 47 on the TSP Request Card.

MFS-27233

Moving and Working on Space Structures

A clawlike device would attach boots to rails.

A memorandum presents, in sketches and brief text, a concept for a boot-toe clip that would help an astronaut move about outside on structures being built at the Space Station. The clip would also help the astronaut maintain a stable position at the worksite. The concept may be adaptable to underwater work on such structures as offshore oil rigs.

According to the concept, clawlike extensions on the toe of a boot would grasp a rail. The wearer would move along the rail by sliding the clip. Changing from one rail to another, the wearer would eventually arrive at the worksite. (The rails would actually be part of the Space Station structure.) The clip would be able to grasp rails that are either vertical or horizontal with respect to the wearer.

A portable rail would also be available. The portable rail would have grappling devices at both ends so that it could bridge between fixed handrails, truss struts, sockets, and other members. With it, an astronaut could use the boot clip to move to worksites outside the Space Station truss structure and on the exterior of Space Station modules.

This work was done by Pat B. McLaughlin of **Johnson Space Center**. To obtain a copy of the report, "Astronaut Boot Toe Translation and Restraint Device," Circle 38 on the TSP Request Card.

MSC-21556

We do Windows And floors. And walls.

Use Plot-IT® to turn complicated ideas into comprehensive graphs. Quickly and easily.



- Over 60 graph types including 3D
- Ultra sharp graphics in full color
- Perform spreadsheet tasks with Plot-IT® Worksheet
- User-customized FORTRAN functions support

• WordPerfect® and Ventura® compatible
And remember, we do Windows. Microsoft Windows® operating system, that is. And IBM OS/2. For a free brochure describing all the Plot-IT® features, write or call now.

Scientific Programming Enterprises

P.O. Box 669 Haslett, Michigan 48840
(517) 339-9859 • FAX: (517) 339-4376

SPE
SCIENTIFIC
PROGRAMMING
ENTERPRISES
Plot-IT®

Circle Reader Action No. 408

Fluxmeters

Solid state circuitry provides greater measurement accuracy, stability, sensitivity, and resolution than other commonly used flux measurement devices.

- Level sensing
- IEEE-4888 interface
- BCD output
- PM/DC, Peak, and AC modes

A complete line of search coils and reference standards are available to meet your specific needs.

mi magnetic
instrumentation inc.

8350 East 48th Street
Indianapolis, IN 46226
(317) 545-2102 (800) 243-9120
FAX (317) 549-0502



Circle Reader Action No. 348



Mathematics and Information Sciences

Hardware, Techniques, and Processes

- 74 VOUS Software Facilitates Development of Other Software
74 Computer Aids Delineation of Boundaries in Farmlands

Books and Reports

- 77 Evaluation of Threshold Functions for Searches Among Data
78 Supercomputers of the Future
78 Assessment of Accuracies of Remote-Sensing Maps

Computer Programs

- 56 Automatic Generation of Countdown-Simulating Software
57 Menu-Driven Solver of Linear-Programming Problems
57 Software for Generating Graphs and Charts
57 Fault-Tree Compiler Program

VOUS Software Facilitates Development of Other Software

Graphical functions and editing of programs and other texts are included.

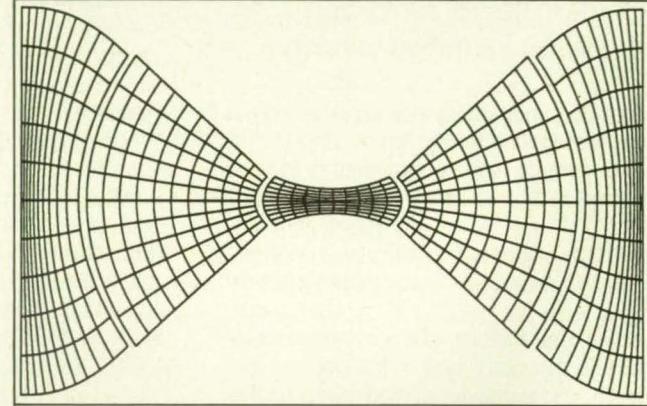
Ames Research Center, Moffett Field, California

The Visual Object Oriented Unification System (VOUS) computer program provides a facility for the development of other, high-level software. VOUS does not replace, but rather extends, preexisting software tools for the development of other software. It provides a comprehensive, graphical, interactive medium for all phases in the development of a computer code from the early exploration of concepts, through the detailed coding-and-error-checking process, to the final reporting of the finished code and compilation of the instruction manual for its use. As such, VOUS simplifies and partly automates the programmer's task, even at what heretofore has been the pencil-and-paper stage of theoretical analysis and preliminary design with its pseudo code fragments and/or flow charts.

The current version of VOUS is the early product of a continuing effort to unify and integrate the various functions provided by such software tools as text editors, graphics editors, text formatters, hypertext (in which textual information can be linked to external references and sources), and structured-decomposition tools. VOUS uses a very general data structure that can manifest itself in a variety of visual forms while enabling the user to create and manipulate easily such abstract objects as large, general-purpose, hierarchically structured programs, data structures, and documents.

From the user's point of view, VOUS functions as a "what-you-see-is-what-you-get" (WYSIWYG) text editor. The user can augment text with pictures, icons, buttons, and structured graphical objects. The text and graphics can be decomposed into logical pages with icons or buttons linking them together. A document can be constructed either in a linear sequence or in a struc-

This Nonrectangular Multiple Grid was created by VOUS. Such grids are particularly useful for the computation of flows in domains of arbitrary shape.



tured top-down hierarchical fashion, depending on its complexity and nature. VOUS can also be used to design templates that can be used in the manner of HyperCard (a type of hypertext) documents to organize information. The unique feature of VOUS is its ability to support objects of various types within a single document.

The fundamental paradigm of VOUS is the traversal of a directed graph, the nodes of which represent data objects or operators. Just as a compiler employs a back end that operates on an abstract syntax tree that represents a program, VOUS enables the construction and execution (i.e., traversal) of a directed graph of polymorphic data nodes, the meaning of which graphs can be defined by the user. Such a visual representation can be very useful in the following applications:

- A general data-flow programming "language" in which a variety of existing software tools can be ordered and connected together graphically. This can provide a procedural specification for combining many large programs together and passing information back and forth between them.
- A graphical UNIX "make" facility in which files are represented by icon nodes and

dependencies are formed by linking icons with arcs. Inner nodes can represent "actions" that are invoked to transform dependent files into target files.

- An n -dimensional "spread sheet" on which polymorphic data cells are formed out of recursive lists rather than only simple arrays. The lists can also represent n -dimensional arrays, the elements of which can, in turn, be other lists or arrays.
- Software systems based on the hypertext and HyperCard systems, where textual information can be linked to external references and sources.
- Higher-level shell programming.
- Creation of complicated data structures and data sets for existing programs; e.g., composing hierarchical, composite grid structures for use in computational fluid dynamics (see figure).
- Outline editors for writing books or other large publications.
- Structured painting and drawing programs.

This work was done by Joseph Olinger, Ramini Pichumani, and Dulce Poncelon of Stanford University for Ames Research Center. For further information, Circle 9 on the TSP Request Card.

ARC-12571

Computer Aids Delineation of Boundaries in Farmlands

Computer-aided delineation is about six times as fast as manual delineation is.

Ames Research Center, Moffett Field, California

The computer-aided stratification (CAS) procedure is a developmental procedure of image-processing computer equipment

and programs that partly automate the delineation of boundaries between areas. These areas, also called "primary samp-

ling units," are images of primarily agricultural lands composed by melding digital Landsat Thematic Mapper data and

Digital Line Graph data from the United States Geological Survey. As used here, "stratification" denotes the division of land areas into land-cover or land-use groups (called "strata") on the basis of interpretation of the Thematic Mapper imagery. Each primary sampling unit is a group of 6 to 10 smaller areas, called "ultimate sampling units." Primary sampling units are typically bounded by such relatively permanent features as roads and rivers. The CAS output data are used as inputs for subsequent sampling procedures from which statistics on the uses of agricultural lands are developed.

The digital Thematic Mapper data on the land area of interest are displayed on a display monitor of 512×512 picture elements of a graphics workstation with an 8-bit intensity in each of the primary colors — red, green, and blue. The range of brightness in each primary color can be adjusted to enhance the subimages of selected land-use features. Next, the Digital Line Graph data are overlaid on the Thematic Mapper imagery for use as references in delineation. By selecting applicable CAS programs, the Digital Line Graph data are edited for display to show such requested features as transportation routes or bodies of water. The CAS software provides precise registration of the Thematic Mapper imagery and Digital Line Graph data by use of tie points and least-squares transformations.

The operator delineates the primary sampling units by using a keyboard and a multibutton cursor on a digitizing tablet. The operator types in an identifying number for the primary sampling unit and stratum in question and delineates the area of interest by using the cursor to enclose it in a polygon. As the polygon is

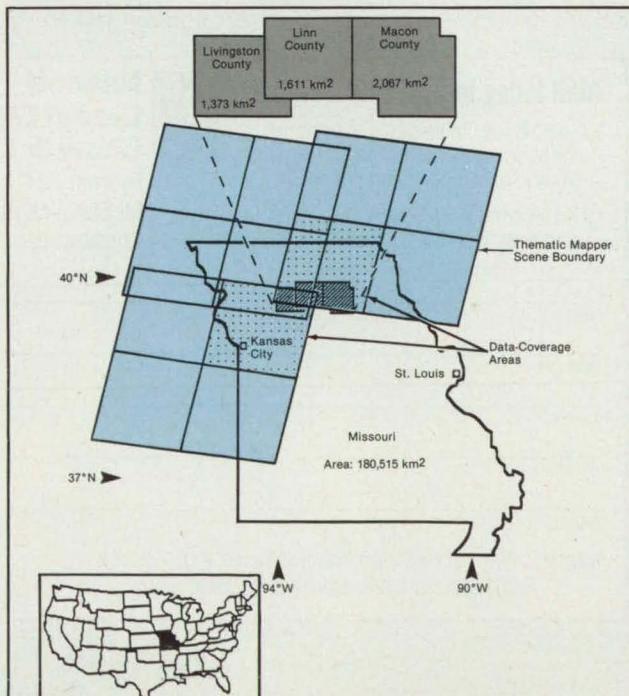
closed, the CAS software automatically annotates it and computes its area. A set of subcommands in one of the CAS programs enables the operator to identify overlaps and gaps between polygons and to correct these deficiencies or otherwise modify the polygons. The polygonal boundaries and associated data on the primary sampling units are written into a polygon file for subsequent processing.

The CAS-assisted procedure was tested by applying it to a three-county area in Missouri (see figure). For comparison, a manual digitization-and-delineation procedure was applied to the same area. The CAS system was found to speed the delineation process by a factor of about 6. Because the boundaries of the primary sampling units can be edited easily on the basis of changes in the land-use pattern, the larger area frames that contain the primary sampling units can be updated more frequently. It was also found that the precision of surveys could be enhanced by using CAS because the simultaneous display of the Thematic Mapper and Digital Line Graph data may increase the probability that an operator will assign a primary sampling unit to the correct stratum.

This work was done by R. Slye of Ames Research Center, T. Cheng and M. Ma of TGS Technology, Inc., and G. Angelici of Sterling Federal Systems. Further information may be found in NASA TM-102243 [N90-16313], "Computer-Aided Boundary Delineation of Agricultural Lands."

Copies may be purchased [prepayment required] from the National Technical Information Service, Springfield, Virginia 22161, Telephone No. (703) 487-4650. Rush orders may be placed for an extra fee by calling (800) 336-4700.

ARC-12805



Look to us for more than quality built Gaussmeters... much more.

GAUSSMETERS

9 MODELS, OVER 100 PROBES



- 3 Channels for Continuous Measurement
- 4-1/2 Digit LCD Display
- 0.1% Instrument Accuracy
- Bus Controllable (IEEE-488 & RS-232)
- Highest Frequency Capability (50 kHz)

All F.W.Bell digital gaussmeters are menu-driven, user friendly, microprocessor based with state-of-the-art circuitry.

Circle Reader Action No. 317

CURRENT SENSORS

OVER 35 MODELS



- High Frequency
- Fast Response (<1μS)
- PC Board or Bulk-head Mounting
- Milliwatt Power Consumption
- Low Cost
- Wide Bandwidth
- Made in U.S.A.

For measurements up to 150 amps dc or ac peak...from dc to 200 kHz

Circle Reader Action No. 319

CURRENT PROBES

MEASURE DC/AC CURRENT AND MORE!

HALL GENERATORS

MEASURE MG TO KG!

F.W. BELL

THE GAUSS METER
PEOPLE...AND MORE

SEND FOR OUR
**FREE
CATALOG!**

6120 Hanging Moss Rd.
Orlando, FL 32807
407-678-6900
Fax: 407-677-5765

For complete
information on
F.W. BELL
products

Circle Reader Action No. 316

Inside every set of plans, there's a beast waiting to break loose.



As a design engineer you've probably faced this beast more times than you care to remember. Perfectly specified plans meeting the harsh realities of the manufacturing environment. An elegant solution sabotaged by inferior components. Vital sub-assemblies that suddenly become unavailable.

Real beasts. And real problems.

But there's one way you can keep the beasts out of your plans. Attend the National Design Engineering Show & Conference at McCormick Place North in Chicago, February 24-27, 1992. Over 950 leading manufacturers of design engineering components, systems and services will be here exhibiting over 15,000 products. In fact, National Design is the largest OEM event in North America and over 30,000 of your professional peers are expected to attend.

These engineers know that there's no better place and time than National Design to source

hard-to-find components, solve some nagging design problems and keep the creative juices flowing. You will, too.

And while you're there, you can also take advantage of the National Design Conference Program, a full range of informative sessions sponsored by the ASME — such as Concurrent

Engineering, the Taguchi Approach and Reverse Engineering.

The National Design Engineering Show & Conference is the better way to keep the beast at bay. For your free Show Preview and Conference program, simply clip and mail in the coupon below. Or call customer services at (203) 964-8287.

Mail today for more information.

- I want to keep the beasts out of my designs.
Please send me a National Design Engineering Show Preview & Conference Program.
- I'm interested in exhibiting.
Please call me with information.



**National
Design Engineering
Show & Conference™**

February 24-27, 1992
McCormick Place North
Chicago, IL

NAME

TITLE

COMPANY

DIVISION/MAIL STOP

ADDRESS

CITY/STATE/ZIP

PHONE/FAX

MAIL TO: Attendee Fulfillment, National Design, P.O. Box 3833
999 Summer Street, Stamford, CT 06905-0833

XAP

Circle Reader Action No. 340

Books and Reports

These reports, studies, handbooks are available from NASA as Technical Support Packages (TSP's) when a Request Card number is cited; otherwise they are available from the National Technical Information Service.

Evaluation of Threshold Functions for Searches Among Data

A quantitative measure of the information content of such a function is presented.

A paper presents an information-theoretical analysis of the problem of building a system of inferences from a large collection of data (data base). More specifically, the problem is to design searches of the data base for informative conjunctive production rules. The results of this analysis may eventually lead to the design of more-economical and more-effective electronic neural networks that can draw inferences from data bases.

The concept of the linear threshold function with binary (0,1) weights is introduced as the paradigm of a search rule. A Boolean function of this kind implements the logical function that means "X of these N inputs are ON," also called an "(X of N) rule." Two examples include a (1 of N) rule, which is an OR function, and an (N of N) rule, which is an AND function. These rules and functions are compatible with the way people reason in searching among data. In terms of the amount of memory necessary to describe a basic logical unit, an (X of N) rule lies between the general linear threshold function on the one hand and the logical AND and OR functions on the other hand.

In this analysis, the J measure is used as a quantitative indication of the information provided by a linear threshold function with binary weights. The J measure was used originally to quantify the expected change in information provided by a production rule and in that context also serves as a measure of how well such a rule predicts the outputs from the given inputs.

There are efficient algorithms for searching through a data base for informative conjunctive production rules. The difficulty with this approach arises in a data base with noisy input values (or where the unmodeled domain information is effectively noise), because in such a case, the use of AND and OR rules requires an exponentially large number of units to describe explicitly the possible representations of a single input with the added noise. The number of units is exponential in the expected number of inputs changed by noise.

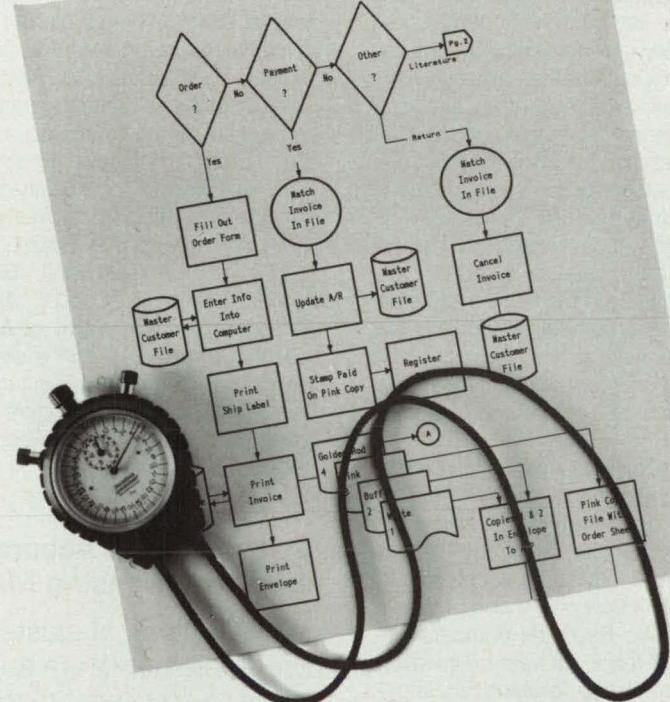
In contrast, a single (X of N) rule cap-

tures the concept of a prototype. A prototype together with a Hamming distance defines a class of inputs centered about the prototype. The (X of N) rule defines a prototype with Hamming distance $N - X$. Prototypes are important units of knowledge for several reasons. One is that they are effective in communicating knowledge with humans. Systems that can be understood at the lowest level by humans allow for justification of results and for possibly better training procedures. A second advantage is the stability of prototype rules with respect to noisy data. The third advan-

tage is that input sample points provide useful starting points for efficient searches for prototype rules with a high J measure.

The paper proposes three ways to conduct an efficient search for the most informative rules (the ones that have the highest J measures). The first is based on a process of specialization in which rules of higher order are extensions of rules of lower order. The second is based on a process of generalization in which rules of lower order are developed from prototypes defined by input samples. The third involves a recursive procedure in which

BY HAND. OR BY NOON.



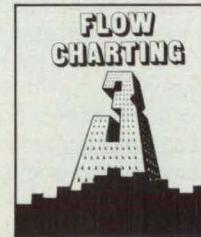
Now, even complex flowcharts that once took days to perfect can be presentation-perfect — in no time!

Quick to master and a snap to use, Patton & Patton's flowcharting software is the standard of both large and small businesses around the world — and is available through all major software dealers.

See your dealer today! Or, for a "live," interactive demo disk, call:

800-525-0082, ext. 2901.

International: 408-778-6557, ext. 2901.



PATTON & PATTON
Software Corporation

Excellence in charting the flow of ideas!

Works on IBM & 100% compatible PC's, supports CGA/EGA/VGA and over 150 dot matrix and laser printers, with multiple print densities and 10 font sizes. Creates multi-page charts, portrait or landscape, on most standard paper sizes. Mouse or keyboard controlled. Supports International Characters.

IBM is a registered trademark of International Business Machines Corporation.

Circle Reader Action No. 499

the set of training attributes is added as a set of derived attributes to a number of the most informative rules.

This work was done by Rodney M. Goodman, John W. Miller, and Padhraic J. Smyth of Caltech for NASA's Jet Propulsion Laboratory. To obtain a copy of the report, "The Information Provided by a Linear Threshold Function With Binary Weights," Circle 40 on the TSP Request Card.

NPO-18113

Supercomputers of the Future

Key technologies will demand speeds and memory capacities that are astounding but nonetheless possible.

A report evaluates the supercomputer needs of five key disciplines: turbulence physics, aerodynamics, aerothermodynamics, chemistry, and mathematical modeling of human vision. The report predicts that these fields will require computer speed greater than 10^{18} floating-point operations per second (FLOP's) and memory capacity greater than 10^{15} words. By way of comparison, today's most advanced computers offer speeds of about 10^9 FLOP's. Despite the disparity, the report predicts that new parallel computer architectures and new structured numerical methods will make the necessary speed and capacity available in the foreseeable future.

Simulations of turbulent flows at modest Reynolds numbers about simple geometries will be used routinely to study the basic physics of turbulence and to test theories of turbulence. The direct simulation of turbulent flow over a complete aircraft at realistic Reynolds numbers will remain out of reach for years. However, large-eddy simulation, in which only large-scale motions are computed and small-scale motions are approximated by simplified mathematical models, will soon be practical for designers.

Computational aerodynamics is advancing rapidly in both research and design. Reasonably complete three-dimensional mathematical models have already been produced. In the future, combined models of aerodynamics, propulsion, structures, and controls will predict integrated aircraft performance.

Computational aerothermodynamics involves equations of motion in which the kinetic energy of the vehicle is high enough to cause dissociation, ionization, and electronic excitation of the impinging air or other gas. Such equations are extremely complicated. For example, on the best of today's computers, about 400 h will be needed to calculate the flow around an

aeroassisted orbital-transfer vehicle. For the foreseeable future, it will be necessary to rely on empirical models to account for chemical reactions and collision dynamics.

Computational chemistry on supercomputers has already made contributions. For example, it is used to predict radiative intensity factors, high-temperature transport properties, and rate constants of reactions in flow fields of aerospace vehicles. Within the next decade, computational chemistry will help develop improved catalysts, fuels, and materials.

The mathematical modeling of human vision promises practical returns of extraordinary value: it could help give robots sight, cure eye diseases, and design displays that optimally exploit the properties of vision. Computational science is being applied to the mathematical modeling of biological visual systems at the cell level and to the development of algorithms to solve specific vision problems. One major challenge is the complete simulation of the primary visual cortex. Another is the development of a synthetic computer vision system for the autonomous guidance of a rotorcraft in low-level flight; this problem is well beyond the capacity of available computers but within the realm of possibility.

This work was done by Victor L. Peterson, John Kim, Terry L. Holst, George S. Deiwert, David M. Cooper, Andrew B. Watson, and F. Ron Bailey of Ames Research Center. To obtain a copy of the report, "Supercomputer Requirements for Selected Disciplines Important to Aerospace," Circle 42 on the TSP Request Card.

ARC-12416

Assessment of Accuracies of Remote-Sensing Maps

Classifications of clusters of picture elements are subjected to statistical tests.

A report describes a study of the accuracies of the classifications of picture elements in a map derived by digital processing of Landsat-multippectral-scanner imagery of the coastal plain of the Arctic National Wildlife Refuge. A classification of the type in question is one in which each picture element is assigned, according to its spectral characteristics, to a class, called a "stratum" in statistical parlance, that represents one of several (in this case, twelve) predetermined categories of vegetation or land cover.

The accuracies of portions of the map are analyzed with the help of a statistical sampling procedure called "stratified plurality sampling," in which all the picture elements in a given cluster are classified in the stratum to which a plurality of them belong. The strata thus derived then pro-

vide the statistical population from which stratified samples are taken and compared with field surveys to determine the accuracies of the classifications. The motivation for this procedure is that picture elements in classes that occur infrequently are more likely to be sampled in their plurality classes than they would be in ordinary stratified-cluster sampling, wherein the strata are usually selected by visual inspection of imagery or of maps (called "base maps") made previously by means independent of the Landsat imagery.

The results of the statistical analysis are tabulated as percentages of correct classifications overall as well as per category of land cover, with associated confidence intervals. The authors conclude that although the percentages correct were disappointingly low for most categories, the study was useful in highlighting sources of errors in classification and in demonstrating the inadequacies of stratified plurality sampling. Spectral confusion among categories, spatially complicated mixtures of land covers of different categories, incomplete descriptions of the categories, and changes in land cover between the time of the classification and the time of this study are found to be sources of errors in the classification. Especially in areas like the Arctic coastal plain, which contains spatially complicated mixtures, the fixed size and shape of the picture elements in the Landsat format and the binary choice of "correct" or "incorrect" for each picture element are sources of much of the error. The appropriate definition of a category is relative to the scale at which it makes sense, and this scale may not coincide with the scale of a picture element. The dependence of the definition of a category on scale causes such errors of classification as inclusions and confusions among picture elements, and can be analyzed correctly only by use of classification schemes more sophisticated than are those that operate on one picture element at a time. The adequacy of the stratified-plurality-sampling scheme used was found to be limited by the insufficient numbers of samples, caused by the insufficiency of resources available for field surveys.

This work was done by Don H. Card of Ames Research Center and Laurence L. Strong of TGS Technology. Further information may be found in NASA TM-101042 [N89-17339], "Accuracy Assessment, Using Stratified Plurality Sampling, of Portions of a Landsat Classification of the Arctic National Wildlife Refuge Coastal Plain."

Copies may be purchased [prepayment required] from the National Technical Information Service, Springfield, Virginia 22161, Telephone No. (703) 487-4650. Rush orders may be placed for an extra fee by calling (800) 336-4700.

ARC-12371



Life Sciences

Hardware, Techniques, and Processes

79 Thin-Membrane Sensor With Biochemical Switch

80 Tissue-Simulating Gel for Medical Research

Thin-Membrane Sensor With Biochemical Switch

The sensor could be used as an alarm for chemical or biological materials.

Marshall Space Flight Center, Alabama

A modular sensor electrochemically detects a chemical or biological agent, indicating the presence of the agent via a gate-membrane-crossing ion current triggered by the chemical reaction between the agent and a recognition protein conjugated to a channel blocker. This sensor could be used in such laboratory, industrial, or field applications as the detection of bacterial toxins in food, military chemical agents in the air, and pesticides or other contaminants in the environment. It could also be used in biological screening for hepatitis, acquired immune-deficiency syndrome, and the like.

The sensor (see figure) includes (a) a bioresponse-simulator module on which the recognition material is mounted and (b) a transducer module on which a gated membrane is affixed to a conductive measuring surface. A self-contained source of dc voltage and an output terminal connected to an alarm circuit are connected to the transducer, and a poised polarizing electrode makes contact with the bioresponse simulator.

The bioresponse simulator module consists of a hydrophilic film-forming layer containing, in a buffer solution of generally neutral pH, the recognition biomolecule for the analyte of interest. Typical examples of the recognition biomolecule might include such a protein as an immunoglobulin-type antibody or albumin, to which a hapten, a segment of nucleic acid, or another protein segment might be attached, depending on the analyte to be detected.

The recognition biomolecule is conjugated to a channel-blocker substance, which prevents the permeation of ions through the gate membrane. Channel-blocker materials include guanidinium compounds (e.g., tetrodotoxin, saxitoxin, and neurotoxic organic derivatives such as tetramethylguanidine), divalent cations (e.g., Ca^{+2} , Sr^{+2} , Ba^{+2} , and Cd^{+2}), and polyvalent cations (such as La^{+3} , Eu^{+3} , Dy^{+3} , and Gd^{+3}). Polyvalent cations, particularly the lanthanides, are the preferred cations because of their substantially greater affinities as channel blockers; effective blockage is achieved at concentrations of the order of one-thousandth those of the divalent cations. Conjugation of lanthanide ions to the protein moiety occurs via coordination bonding and may be

performed in aqueous buffer solutions or while the cation is bound to ion channels in the gate membrane; in the latter case, the channels remain blocked. The reaction between the channel blocker (conjugated to the recognition protein) and the analyte of interest at the ion-channel site in the gate membrane results in the removal of the blocker from the ion channel and the consequent onset of ion current.

Ion channels conductive to monovalent cations serve as the gate material in the gate membrane. Examples include physiological sodium channel proteins, acetylcholine receptor protein, and such channel-forming antibiotics as the gramicidins; the gramicidins are preferred because of their high conductance, stability, ease of handling, high loading capacity, and availability. Physiological membranes containing ion channels can be used directly. Alternatively, ion channels can be inserted from solution phase into artificial membranes previously prepared by conventional Langmuir-Blodgett techniques.

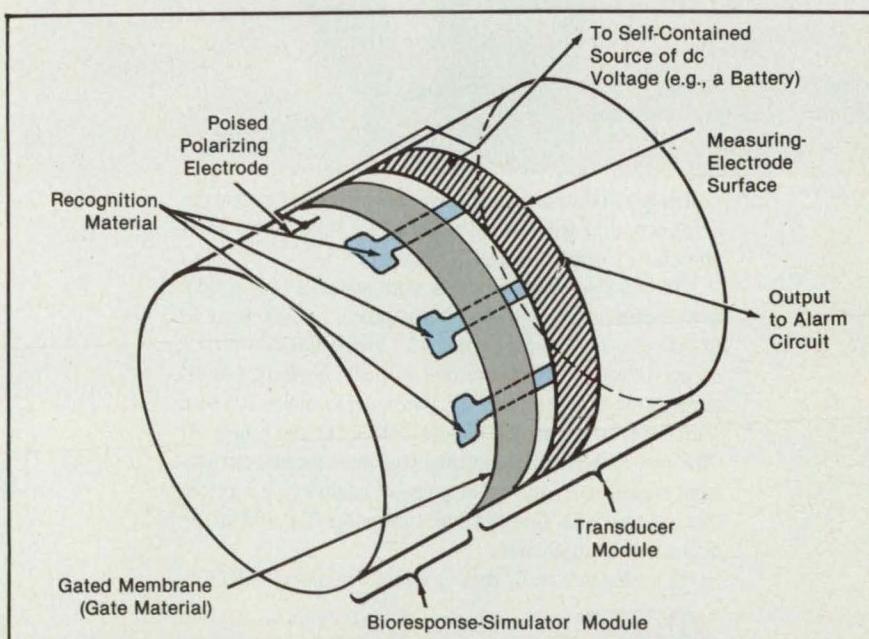
The gate membrane consists of a hydrophobic material that is essentially impermeable to ions, particularly monovalent cations. Gate membranes can be pre-

pared from phospholipids or from such polymerizable unsaturated organic compounds as diacetylenic derivatives of fatty acids.

In the poised state, the recognition material is bound to the gate material in the membrane in such a way as to block permeation of the membrane by ions. When the sensor is exposed to a chemical or biological agent of interest, this agent reacts with the recognition material, pulling it away from the gate material. This, in turn, enables an ion current to flow across the membrane. The resulting surge of current is sensed at a measuring-electrode surface in the transducer, triggering an alarm.

This work was done by George D. Case of Resource Technologies Group, Inc., and Jennings F. Worley of West Virginia University for Marshall Space Flight Center. For further information, Circle 1 on the TSP Request Card.

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Marshall Space Flight Center [see page 14]. Refer to MFS-26121.



The Thin-Membrane Sensor functions like a biochemical switch when exposed to the substance(s) to be detected. (The individual components are exaggerated for visual clarity and are not dimensionally to scale.)



Tissue-Simulating Gel for Medical Research

The nonhardening, translucent gel more nearly simulates soft human or animal tissue.

Langley Research Center, Hampton, Virginia

A unique gel combines a number of properties important for use in the simulation of soft human or animal tissue in medical research. Because of its thermal stability, the gel should be especially useful for the investigation of hyperthermia as a treatment for cancer.

A number of formulas exist for producing tissue-simulating gels. Many of these are based on agars, simple hydrated col-

lagen gels, or polyacrylimides. Hydrated gels dry out, some gels melt at the high temperatures experienced in hyperthermia experiments, some become hosts to micro-organisms, and some are simply too expensive or difficult to make. The new formulation overcomes most of these deficiencies.

The new gel differs in that it includes a substantial percentage of ethylene glycol

in the solution. The first step in preparing the material is to dissolve sodium or potassium chloride in distilled water to attain the desired dielectric constant. A 300-bloom gelatin is then stirred into the solution in the proportions of 10 g per 100 mL of the final quantity. The resulting slurry is set aside at room temperature for several hours, with occasional stirring.

The mixture is then heated slowly to 140 to 150 °F (60 to 66 °C) with constant stirring. It is kept in this state until all of the gelatin is dissolved. The ethylene glycol is then added and stirred to form the final solution. It is then removed from the heat and deaerated. The mixture can be stored at this time.

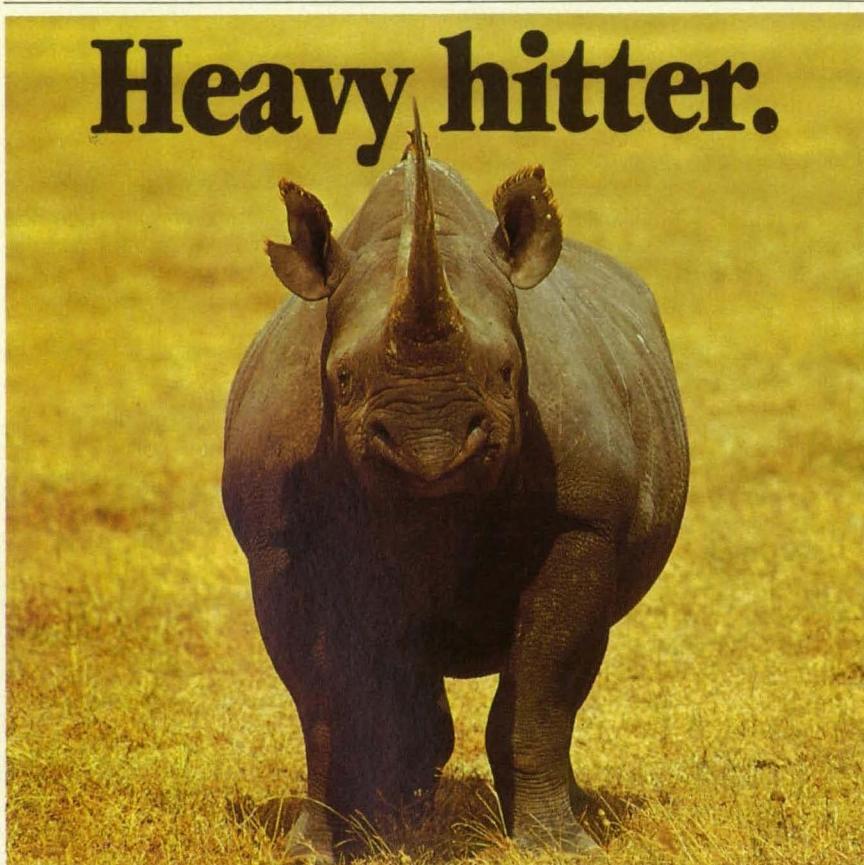
The mixture solidifies, but can be remelted when needed. When a tissue phantom is required, the material is melted and catalyzed. Formaldehyde is added in the ratio of 10 mL per 100 mL of solution. The solution must be mixed thoroughly and poured into the mold quickly. The working life is less than 10 minutes. After cross-linking has taken place, the gel will no longer melt and can be removed from the mold.

The gel can be modified to be softer or harder by altering the proportions of the ingredients. Fillers can be added to change the electrical, mechanical, heat-conducting, or sound-conducting/scattering properties. In this manner, different types of tissues can be simulated. The gel does not support the growth of micro-organisms, and it neither hardens nor dries. A polyurethane skin can be sprayed on the gel to provide resistance to abrasion if desired.

The gel can be molded to any desired shape and has sufficient mechanical strength to maintain that shape without a supporting shell. In the absence of a shell, the ultrasonic transmissive characteristics are only those of the gel itself, thus simplifying the analysis of experimental results. The gel is rubbery, so that hypodermic needles or catheters can be inserted as into flesh. Substances can be injected as into real tissue. In addition, because the gel is reasonably transparent, it is possible to inspect the interior visually.

This work was done by John A. Companion of Planning Research Corp. for Langley Research Center. For further information, Circle 16 on the TSP Request Card.

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Langley Research Center [see page 14]. Refer to LAR-14036



Bruce Coleman photo

He's one of the most formidable natural combat systems in existence, and we can tell you exactly how many force-pounds he'll exert at the point of impact.

NTS can also simulate shock with some of the world's most sophisticated dynamic test equipment: 45,000 force-lb. to 200 g's; 25,000 g's pyroshock; hydroshock to 30 g's, 30 ms. Other capabilities include acoustic levels to 170 dB, acceleration of 800 g's/250 lb., thermal vacuum to 10^{-8} torr, static loads exceeding 100,000 lbs, EMI/RFI of 200 V/m to 40 GHz, fast cookoff, environmental chambers for any environment conceivable, and a full range of engineering services that include FMEA, fine grid and stick model FEA, and mathematical behavior analysis.

For testing that really packs a punch, call or write NTS.



Engineers and technicians: Employment opportunities are available

National
Technical
Systems

20988 Golden Triangle Road
Saugus, CA 91350
West (805) 259-8184
East (508) 263-2933

Subject Index of all 1991 Briefs



The following pages contain a cross-referenced index of all technical briefs published in *NASA Tech Briefs* during 1991 (Volume 15). You can receive copies of these briefs and their accompanying Technical Support Packages (TSPs) by contacting NASA's Center for AeroSpace Information (see page 14).

A

ABERRATION

Ruling blazed, aberration-corrected diffraction gratings
Oct page 97 GSC-13240

ACCELERATION TOLERANCE

Effect of bed rest on tolerance to acceleration
Mar page 68 ARC-12400

ACCUMULATORS (COMPUTERS)

Digital accumulators in phase- and frequency-tracking loops
Aug page 30 NPO-17909

Sign-and-magnitude up/down counter
Oct page 24 NPO-17760

ACETATES

Manufacturing ethyl acetate from fermentation ethanol
Sep page 84 NPO-17923

ACOUSTIC LEVITATION

Reducing thermal conduction in acoustic levitators
Jun page 120 NPO-17620
Acoustic levitator with furnace and laser heating
Oct page 95 NPO-18035

ACOUSTIC MEASUREMENT

New sensors for flow velocity and acoustics
Dec page 76 ARC-12577

ACOUSTO-OPTICS

Three-dimensional acousto-optical spectrum analyzer
Sep page 62 NPO-18122

Two-dimensional acousto-optical spectrum analyzer
Sep page 72 NPO-18092

ACRYLATES

Fast-acting rubber-to-coated-aluminum adhesive
May page 44 MFS-28434

ADA (PROGRAMMING LANGUAGE)

General-purpose Ada software packages
Feb page 51 NPO-17983

Ada namelist package
May page 50 NPO-17984

ADAPTIVE CONTROL

Experiments in adaptive control of a flexible structure
Feb page 31 NPO-17846

Adaptive control of large vibrating, rotating structures
Sep page 90 NPO-17471

ADDITION RESINS

Tough, high-performance, thermoplastic addition polymers
May page 46 LAR-10000

ADHESION

Measuring adhesion and friction forces
Jan page 39 LEW-14903

ADHESION TESTS

Grit blasting scribes coats for tests of adhesion
Jul page 84 MFS-28452

ADHESIVES

Fast-acting rubber-to-coated-aluminum adhesive
May page 44 MFS-28434

NEW POLYIMIDE HAS MANY USES

Sep page 85 LAR-14163

PRESSURE ROLLER FOR TAPE-LIFT TESTS

Sep page 105 GSC-13230

ADSORBENTS

Adsorbent removes traces of oxygen
Apr page 67 NPO-17947

AERODYNAMIC BALANCE

Effects of molecular processes on trim angles
Apr page 62 ARC-12566

AERODYNAMIC HEAT TRANSFER

Computed hypersonic flow about a sharp cone
Oct page 85 ARC-12675

AERODYNAMICS

Computing the dynamics of helicopters
Feb page 46 ARC-12337

COMPUTING LINEAR MATHEMATICAL MODELS OF AIRCRAFT

Mar page 45 ARC-12422

AERODYNAMICS OF MISSILES: PRESENT AND FUTURE

Oct page 83 ARC-12188

COMPUTED FLOW ABOUT THE INTEGRATED SPACE SHUTTLE

Oct page 80 ARC-12685

Numerical aerodynamic simulation program

Oct page 80 ARC-12245

EXPERIMENTS TO VERIFY COMPUTED FLOWS

Nov page 80 ARC-12231

AEROELASTICITY

Calculating flow through a helicopter rotor
May page 55 ARC-12202

CALCULATION OF AEROELASTIC TRANSIENTS USING EULER EQUATIONS

May page 51 ARC-12351

TRANSONIC AEROELASTICITY ANALYSIS FOR HELICOPTER ROTOR BLADE

Jun page 60 ARC-12550

PLACING CONTROL SURFACES TO SUPPRESS AEROELASTIC FLUTTER

Jul page 71 ARC-12411

FREQUENCY-DOMAIN IDENTIFICATION OF AEROELASTIC MODES

Dec page 73 ARC-12407

AEROSPACE PLANES

Simulating the performance of a scramjet
Mar page 42 ARC-12338

COMPUTATIONAL FLUID DYNAMICS IN AEROSPACE

Apr page 86 ARC-12107

OVERVIEW OF AEROTHERMO-DYNAMICS OF HYPERSONIC FLIGHT

Sep page 51 ARC-12217

AIR

Real-gas properties of air and air-plus-hydrogen mixtures
Jan page 30 ARC-12275

ALGORITHM COMPUTES HYPersonic FLOW OF AIR

Sep page 76 ARC-12623

AIR SAMPLING

Collectors or airborne and spaceborne particles
Sep page 74 NPO-18183

AIR TO AIR MISSILES

Computing the no-escape envelope of a short-range missile
Jul page 71 ARC-12404

AIR TRAFFIC CONTROL

Simulation test of descent advisor
Jul page 36 ARC-12626

AIRBORNE LASERS

Airborne laser polarization sensor
Feb page 34 GSC-13314

AIRBORNE/SPACEBORNE COMPUTERS

Versatile, fast computer core
Sep page 50 GSC-13364

AIRCRAFT CONTROL

Precise autohover control for a helicopter
Oct page 36 ARC-12243

AIRCRAFT LANDING

Back azimuth guidance in departures and missed approaches
Jul page 39 ARC-12611

AIRCRAFT SPIN

Selectable towline spin-chute system
Nov page 84 LAR-14322

AIRFOILS

Leading-edge pop-up spoiler for airfoil
Mar page 52 LAR-13781

ALGEBRA

Spatial-operator algebra for robotic manipulators
Aug page 88 NPO-17770

ALGORITHMS

Recursive inversion by finite-impulse-response filters
Jan page 51 ARC-12247

Algorithm for solution of subset-regression problems
Feb page 66 ARC-12145

Conjugate gradient algorithms for manipulator simulation
Apr page 84 NPO-17929

Mode-switching algorithms for antenna servocontroller
Sep page 56 NPO-17489

Estimating SAR Doppler shifts from homogeneous targets
Oct page 102 NPO-17869

Estimating SAR Doppler shifts from quasi-homogeneous targets
Oct page 105 NPO-17905

Relative-error-covariance algorithms
Oct page 112 NPO-17956

Algorithm derives rules from data
Nov page 96 NPO-18114

Removing ambiguities in remotely sensed winds
Nov page 99 NPO-18079

LIGHT MEASUREMENT

SYSTEMS

RADIOMETERS



UV CURING RADIOMETERS



SPECTRO RADIOMETERS



PHOTOMETERS



LASER POWER METERS



INTEGRATING SPHERES

APPLICATIONS

- UNDERWATER/ENVIRONMENTAL
- LASER POWER
- PHOTOMETRY
- PHOTORESIST
- PHOTOTHERAPY
- RADIOMETRY
- TRANSMISSION REFLECTANCE
- UV CURING
- UV HAZARDS

international light INC.

17 GRAF ROAD
NEWBURYPORT, MA 01950 U.S.A.

■ TEL. 508-465-5923
■ FAX 508-462-0759
■ TELEX 94-7135

ASK FOR ALL NEW
LIGHT MEASUREMENT CATALOG

Quiet!



Listen to what they're saying!

I put 8 oz. Tufoil in my wife's 1977 Mercury and didn't tell her. A week later she asked me why her car was idling faster and had more pep. I told her about the Tufoil and she was pleased. (S.S. Az)

Recently while driving, my car lost oil pressure due to a defective oil plug. The service station owner stated the car's engine was saved from damage due to your fine product. Thanks! (G.R. New Jersey)

You have invented a masterpiece! Your product surpasses all my expectations! (C.B. New York)

**One 8 oz. - \$ 17.75 (ship. incl.)
Two 8 oz. - 29.00 (ship. incl.)
1 Quart - 38.95 (ship. incl.)
1 Gallon - 131.00 (ship. incl.)**

1-800-922-0075

ORDER TODAY

Fluoramics, Inc. N192

18 Industrial Avenue
Mahwah, NJ 07430

My check or money order for \$ _____ is enclosed.
Charge my credit card:

Am. Express Master Card Visa
Card No. _____

Exp. Date _____

Phone No. _____

Name _____

Address **UPS Shipping Address**

City _____

State _____ Zip _____

(N.J. residents please add 7% sales tax.)

Algorithm reveals sinusoidal component of noisy signal
Dec page 86 MFS-29688

ALIGNMENT

Alignment tool for inertia welding
Mar page 59 MFS-29667

ALUMINUM GALLIUM ARSENIDES

Alternative Al_xGa_{1-x}As/GaAs transistors for neural networks
Sep page 26 NPO-18177

High-gain Al_xGa_{1-x}As/GaAs transistors for neural networks
Sep page 24 NPO-18101

High-power AlGaAs quantum-well lasers on Si substrates
Sep page 26 NPO-17988

ALUMINUM GRAPHITE COMPOSITES

Open-section composite structural elements
Feb page 45 MFS-26112

AMBIENT TEMPERATURE

Higher performance ambient-temperature heat pipe
May page 57 MSC-21515

ANALYSIS (MATHEMATICS)

Analysis of lock detection in Costas loops
Jul page 38 NPO-18102

Strain center for analysis of forces
Aug page 68 NPO-17966

Software for multivariable frequency-domain analysis
Sep page 87 LAR-14119/22

Contamination analysis program
Oct page 66 NPO-17982

HyperCLIPS
Oct page 69 NPO-18087

Integrated analysis capability program
Dec page 54 GSC-13341

ANGLES (GEOMETRY)

Device measures angle of deployment
Apr page 36 GSC-13351

ANIMALS

Microgravity experiments on animals
Apr page 101 ARC-12343

ANIMATION

Program generates images of solid surfaces
Jan page 38 MSC-21630/49

ANTENNA ARRAYS

Digital signal combiner for receiving-antenna feed array
Jun page 32 NPO-18140

Reducing cross-polarized radiation from a microstrip antenna
Aug page 20 NPO-18147

ANTENNAS

Fast approximate analysis of modified antenna structure
Mar page 64 NPO-17901

Caustic singularities of high-gain, dual-shaped reflectors
Apr page 38 NPO-18046

End-loaded, cavity-backed, cross-slot antennas
Sep page 30 NPO-18100

(N.J. residents please add 7% sales tax.)

Mode-switching algorithms for antenna servocontroller
Sep page 56 NPO-17489

ANTIFRICTION BEARINGS

Flexure bearing reduces startup friction
Nov page 72 LAR-14348

ANTIREFLECTION COATINGS

Coating solar cells by microwave plasma deposition
May page 60 NPO-17035

Solar-cell cover glass would reduce reflectance loss
Jul page 22 LEW-14942

APERTURES

Multiperture spectrometer
Dec page 38 NPO-18011

APPLICATIONS PROGRAMS (COMPUTERS)

Another program for generating interactive graphics
Jul page 65 GSC-13276

Program for generating interactive displays
Jul page 64 GSC-13275

HyperCLIPS
Oct page 69 NPO-18087

DOS batch files as control programs
Nov page 101 MSC-21570

Closed-cycle nutrient supply for hydroponics
Jul page 90 MSC-21655

ARC WELDING

Fast, nonspattering inert-gas welding
Feb page 61 MFS-29848

Compact gas/tungsten-arc welding torch
Jun page 108 MFS-29668

Plasma-arc torch for welding ducts in place
Jun page 118 MFS-29701

Effects of heat sinks on VPVA welds
Oct page 99 MFS-27240

Automatic control of length of welding arc
Nov page 91 MSC-21473

Jointed holder for welding electrodes
Nov page 95 MFS-29739

Smaller coaxial-view welding torch
Dec page 82 MFS-29744

Architecture for intelligent control of robotic tasks
Aug page 28 NPO-17871

Study of candidate architectures for data processor
Nov page 48 MSC-21690

Variable-speed instrumented centrifuges
Sep page 101 KSC-11383

Adaptive control of large vibrating, rotating structures
Sep page 90 NPO-17471

ARTIFICIAL INTELLIGENCE
Modular, multilayer perceptron
Mar page 31 NPO-17860

Orthogonal patterns in a binary neural network
May page 72 ARC-12454

Terminal attractors in neural networks
Jul page 89 NPO-17832

Automated scheduling via artificial intelligence
Aug page 86 NPO-18029

Valve- and switch-monitoring computer program
Nov page 98 MSC-21720

Artificial intelligence in computational fluid dynamics
Dec page 73 ARC-12445

Neural-network simulator
Dec page 48 MSC-21638

ASSOCIATIVE PROCESSING (COMPUTERS)

Trinary associative memory would recognize machine parts
Sep page 52 NPO-17850

Aiming schedule for orbiting astrometric telescope
Aug page 57 NPO-12103

Digital control of a telescope in an airplane
Aug page 29 ARC-12399

Estimating rain attenuation in satellite communication links
Dec page 48 LEW-14979

Nitrous oxide in the antarctic stratosphere
Apr page 63 ARC-12223

Geographical variations in measured lightning fields
Sep page 78 KSC-11449

Global reference atmosphere model—1988
Jan page 35 MFS-28397

Transformations for atmospheric-radiation calculators
Jul page 42 NPO-18026

Estimating atmospheric turbulence from flight records
Jul page 45 ARC-12589

Calculation of pneumatic attenuation in pressure sensors
Mar page 47 ARC-12210

Model of bearing with hydrostatic damper
Jan page 43 MFS-29654

ATTITUDE INDICATORS
Digital pitch-and-roll monitor
Sep page 66 LAR-14247

AVIATION METEOROLOGY
Estimating atmospheric turbulence from flight records
Jul page 45 ARC-12589

AVIONICS
Electromagnetic interference in new aircraft
Aug page 32 ARC-12161

AVIONICS
Knowledge-based flight-status monitor
Dec page 31 ARC-12712

AVOIDANCE
Preventing aim at an undesired target
Aug page 24 NPO-18077

AXIAL FLOW
Low-leakage inlet swirl brake
Oct page 74 MFS-29608

B

BACKUPS
How safe is control software
Jun page 126 ARC-12710

BALL BEARINGS
Low-wear ball-bearing separator
Feb page 56 MFS-29666

Bearing-cartridge damping seal
Aug page 77 MFS-29657

Gradient tempering of bearing races
Sep page 107 MFS-28496

Flexure bearing reduces startup friction
Nov page 72 LAR-14348

Monitoring bearing vibrations for signs of damage
Dec page 78 MFS-29734

BALLOONS
Lightweight valve closes duct quickly
Dec page 64 MFS-28511

BANDPASS FILTERS
Nonlinear dynamic compensation for feedback control
Nov page 47 NPO-17993

BARIUM TITANATES
Photorefractive crystal compresses dynamic range of image
Oct page 37 NPO-18098

BATCH PROCESSING
DOS batch files as control programs
Nov page 101 MSC-21570

BATHING
Portable water-saving shower for emergencies
Oct page 115 MFS-28459

BEAM SPLITTERS
Beam splitter for welding-torch vision system
May page 67 MFS-29641

BEAMS (SUPPORTS)
Temperature, thermal stress, and creep in a structure
Nov page 81 ARC-12213

BEARINGS
Model of bearing with hydrostatic damper
Jan page 43 MFS-29654

Lubrication of nonconformal contacts Feb page 57 LEW-14882	BOLTS Staking pliers Sep page 104 MSC-21725	C	Program calibrates strain gauges Dec page 52 MSC-21399	Optimum platinum loading in Pt/Sn ₂ O ₃ CO-oxidizing catalysts Jun page 56 LAR-14183	Filament winding of carbon/carbon structures Oct page 95 NPO-18163
Modifications of hydrostatic-bearing computer program Apr page 89 MFS-29638	Designing applications for fasteners Oct page 101 LEW-15081	C-141 AIRCRAFT Digital control of a telescope in an airplane Aug page 29 ARC-12399	CANS Crack-free, nondistorting can for hot isostatic pressing Oct page 98 LEW-14990	Automatic rejection of multimode laser pulses Dec page 24 NPO-17777	Vacuum powder injector Oct page 93 LAR-14179
Grease inhibits stress-corrosion cracking in bearing race Aug page 58 MFS-29664	Lockwasher strongly resists disassembly Nov page 93 MFS-29696	CALCIUM CARBONATES Impregnating coal with calcium carbonate Dec page 46 NPO-17696	CAPACITORS Ferroelectric memory capacitors for neural networks Apr page 26 NPO-17973	CARBON FIBER REINFORCED PLASTICS Impact damage in carbon/epoxy and carbon/PEEK composites Apr page 72 MFS-27245	CARRIER WAVES Analysis of lock detection in Costas loops Jul page 38 NPO-18102
Gradient tempering of bearing races Sep page 107 MFS-28496	BOMBS (ORDNANCE) Ultrasonic device would open pipe bombs Sep page 108 NPO-17951	CALCULUS OF VARIATIONS Norms and completeness in variational methods May page 71 NPO-18071	CALIBRATING Statistical partial calibration of polarimetric SAR imagery Feb page 40 NPO-17888	CARBON FIBERS Lightweight substrates for mirrors Jan page 32 NPO-17854	CASSEGRAIN ANTENNAS Digital signal combiner for receiving-antenna feed array Jun page 32 NPO-18140
Servo reduces friction in flexure bearing Nov page 74 LAR-14349	BONDING Bonding aramid rope to metal fitting Jan page 47 MSC-21618	CALIBRATION Fast-acting rubber-to-coated-aluminum adhesive May page 44 MFS-28434	CALIBRATING Statistical partial calibration of polarimetric SAR imagery Feb page 40 NPO-17888	CARBON DIOXIDE LASERS Platinum/tin oxide/silica gel catalyst oxidizes CO Apr page 66 LAR-14155	CASSEGRAIN OPTICS Solar concentrator has wider cone of acceptance Apr page 56 MFS-28295
Dynamic tester for rotor seals and bearings Dec page 80 MFS-28493	Eliminating unbonded edges in explosive bonding Jan page 45 LAR-14096	BOOSTER ROCKET ENGINES Distributed-computer system optimizes SRB joints Aug page 24 LAR-14311	BOUNDRY LAYERS Measurements of boundary layers on a compressor blade Apr page 83 LEW-14748	kevex	
Monitoring bearing vibrations for signs of damage Dec page 78 MFS-29734	BOUNDRY LAYER CONTROL Making large suction panels for laminar-flow control Feb page 61 LAR-13844	BOUNDRY LAYER FLOW A general-coordinate formulation for boundary-layer flow Dec page 59 ARC-12465	BOUNDRY LAYERS Reducing water/hull drag by injecting air into grooves Dec page 59 LAR-14078	RADIOGRAPHY	
Monitoring engine vibrations for spectrum of exhaust Dec page 79 MFS-29733	BOUNDRY LAYER TRANSITION Laminar-separation sensor Mar page 50 LAR-14314	BOUNDRY LAYER FLOW A general-coordinate formulation for boundary-layer flow Dec page 59 ARC-12465	BOUNDRY LAYERS Reducing water/hull drag by injecting air into grooves Dec page 59 LAR-14078	Radiography is just one of the many applications possible with Kevex X-RAY's patented portable X-ray source, the PXS.	
BED REST Effect of bed rest on tolerance to acceleration Mar page 68 ARC-12400	BETA PARTICLES Betavoltics of increased power Aug page 23 NPO-17817	BOUNDRY LAYER FLOW A general-coordinate formulation for boundary-layer flow Dec page 59 ARC-12465	BOUNDRY LAYERS Reducing water/hull drag by injecting air into grooves Dec page 59 LAR-14078	The PXS can create new market opportunities for your products. The design eliminates the bulk associated with conventional X-ray systems allowing your products to be portable, lightweight and compact.	
Physiology of prolonged bed rest Mar page 68 ARC-12241	BIOREACTORS Membrane bioreactor with pressure cycle Jan page 55 NPO-17974	BOUNDRY LAYER FLOW A general-coordinate formulation for boundary-layer flow Dec page 59 ARC-12465	BOUNDRY LAYERS Reducing water/hull drag by injecting air into grooves Dec page 59 LAR-14078	Some new products to date include:	
BENDING Mixed-mode-bending delamination apparatus Aug page 73 LAR-13985	BIPOLAR TRANSISTORS Doping to reduce base resistances of bipolar transistors May page 22 NPO-17948	BOUNDRY LAYER FLOW A general-coordinate formulation for boundary-layer flow Dec page 59 ARC-12465	BOUNDRY LAYERS Reducing water/hull drag by injecting air into grooves Dec page 59 LAR-14078	<ul style="list-style-type: none"> ▪ A portable real-time imaging system for detection of tampered products in the field ▪ A radically different altimeter for the next generation of aircraft ▪ An on-line thickness gauge used in 100°C environments ▪ A compact X-ray fluorescence system ▪ A tabletop double crystal diffractometer ▪ An airborne meteorological device for measuring particle distribution 	
BISMALEIMIDE New synthesis of high-performance bismaleimides Jul page 54 LAR-13958	BRAIN Processing of visual information in primate brains Mar page 67 NPO-17900	BOUNDRY LAYER FLOW A general-coordinate formulation for boundary-layer flow Dec page 59 ARC-12465	BOUNDRY LAYERS Reducing water/hull drag by injecting air into grooves Dec page 59 LAR-14078	All possible because of the self-contained compact X-ray energy source, the PXS.	
BIT ERROR RATE Multiple-bit errors caused by single ions Jul page 38 NPO-18075	BRACKES (FOR ARRESTING MOTION) Bidirectional drive-and-brake mechanism Oct page 88 MSC-21540	BOUNDRY LAYER FLOW A general-coordinate formulation for boundary-layer flow Dec page 59 ARC-12465	BOUNDRY LAYERS Reducing water/hull drag by injecting air into grooves Dec page 59 LAR-14078	Kevex X-RAY integrated a miniature X-ray tube and a high voltage power supply into one compact, 5 lb. package. Operational from a 12 volt DC battery, this highly regulated, highly stable source has all the high voltage components molded internally. As a result there are no high voltage cables or connectors to work around.	
BLADDER Ultrasonic device monitors fullness of the bladder Sep page 115 LAR-13689	BLADE SLAP NOISE Research in helicopter noise Aug page 74 ARC-12171	BOUNDRY LAYER FLOW A general-coordinate formulation for boundary-layer flow Dec page 59 ARC-12465	BOUNDRY LAYERS Reducing water/hull drag by injecting air into grooves Dec page 59 LAR-14078	Designed, manufactured, and sold only by Kevex X-RAY. Call or write Kevex X-RAY today for information on our complete line of portable sources including the 10 micron focal spot PXS.	
BLOOD CELLS Human expertise helps computer classify images Oct page 110 MSC-21737	BLOOD PUMPS Numerical simulation of flow through an artificial heart Dec page 66 ARC-12478	BOUNDRY LAYER FLOW A general-coordinate formulation for boundary-layer flow Dec page 59 ARC-12465	BOUNDRY LAYERS Reducing water/hull drag by injecting air into grooves Dec page 59 LAR-14078	kevex X-RAY	P.O. Box 66860 Scotts Valley, CA 95066 408-438-5940
BLUNT BODIES Algorithm computes hypersonic flow of air Sep page 76 ARC-12623	BRITTENESS Push tester for laminated films Sep page 92 NPO-18063	BOUNDRY LAYER FLOW A general-coordinate formulation for boundary-layer flow Dec page 59 ARC-12465	BOUNDRY LAYERS Reducing water/hull drag by injecting air into grooves Dec page 59 LAR-14078		
BOLOMETERS Characterization of electrical response of photodetector Dec page 24 GSC-13349	BUFFER STORAGE Deep FIFO surge buffer May page 32 ARC-12159	BOUNDRY LAYER FLOW A general-coordinate formulation for boundary-layer flow Dec page 59 ARC-12465	BOUNDRY LAYERS Reducing water/hull drag by injecting air into grooves Dec page 59 LAR-14078		
BUTT JOINTS Stereoscopic video weld-seam tracker Mar page 29 MFS-26116					

What is Desktop Signal Processing all About?

- 25 to 450 MFLOPs and Beyond
- 1.6 G bytes/sec system bandwidth
 - 8, 12 & 16 bit Analog I/O
- 32 bit Digital I/O up to 100 Mbytes/sec
 - Macintosh®, IBM® & SUN® hosts
 - Extensive Signal Processing Library

It's About Time.



DOLPHIN SCIENTIFIC

2698 Junipero Ave, Suite 104 Long Beach, CA 90806-2124
voice (213)988-8930 fax (213)988-8935

©1990 Dolphin Scientific, Inc. All Rights Reserved.
All other trademarks mentioned are held by their respective companies.

Circle Reader Action No. 510

System would keep telescope reflector segments aligned
Apr page 40 NPO-17903

CATALYSTS
Platinum/tin oxide/silica gel catalyst oxidizes CO
Apr page 66 LAR-14155

Optimum platinum loading in Pt/Sn₂ CO-oxidizing catalysts
Jun page 56 LAR-14183

CATHODES
Behavior of NbSe₃ cathode in rechargeable Li cell
Mar page 35 NPO-17648

CAUSTICS (OPTICS)
Caustic singularities of high-gain, dual-shaped reflectors
Apr page 38 NPO-18046

CAVITY RESONATORS
Quasi-optical millimeter-wavelength resonator
Jun page 16 NPO-17919

Microwave levitation of small objects
Sep page 109 NPO-18006

CELLS (BIOLOGY)
Cloned hemoglobin genes enhance growth of cells
Jan page 54 NPO-17517

CENTRAL PROCESSING UNITS
Improved remapping processor for digital imagery
Jul page 26 MSC-21481

Versatile, fast computer core
Sep page 50 GSC-13364

Programmable maintenance processor for XAIDS
Oct page 31 ARC-12164

CENTRIFUGAL CASTING
Casting of multilayer ceramic tapes
Jun page 110 NPO-17166

CENTRIFUGES
Variable-speed instrumented centrifuges
Sep page 101 KSC-11383

Optimum platinum loading in Pt/Sn₂ CO-oxidizing catalysts
Jun page 56 LAR-14183

CERAMIC FIBERS
Fabrication of ceramic mats
Apr page 94 NPO-17210

CERAMICS
Radiographic detection of voids in SiC and SiN ceramics
Jan page 34 LEW-14881

Making three-layer solid electrolyte/electrode sandwiches
May page 67 NPO-17078

Casting of multilayer ceramic tapes
Jun page 110 NPO-17166

High-temperature insulating gap filter
Jul page 52 MSC-21644

CHALLENGER (ORBITER)
Placement of O-rings in solid rocket booster
Aug page 76 NPO-18008

CHANNEL FLOW
Pressure fluctuations in simulated turbulent channel flow
Oct page 80 ARC-12597

CHARCOAL
Adsorbent removes traces of oxygen
Apr page 67 NPO-17947

CHARGE COUPLED DEVICES
Three-dimensional acousto-optical spectrum analyzer
Sep page 62 NPO-18122

Flexible generation of array-detector timing signals
Oct page 35 GSC-13345

Low-noise charge-coupled device
Oct page 20 NPO-18031

Altering interline transfer in a CCD to reduce saturation
Dec page 30 NPO-17935

CHEMICAL REACTORS
Monatomic-oxygen reactors for materials testing and surface chemistry
Jun page 48 MSC-21505

Silane-pyrolysis reactor with nonuniform heating
Jun page 104 NPO-17932

CHEMICAL STERILIZATION
Apparatus circulates sterilizing gas
Oct page 116 MSC-21552

CODING
Multiple-symbol detection of multiple-trellis-coded MDPSK
Jun page 38 NPO-18043

Matrix encoding for correction of errors
Oct page 108 NPO-17834

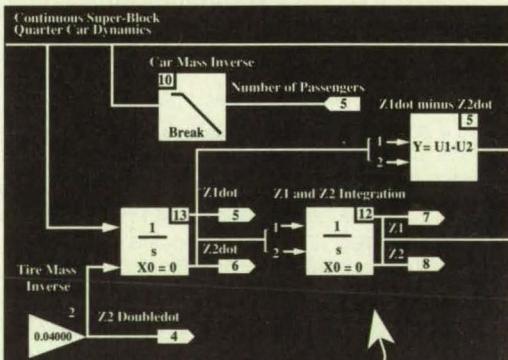
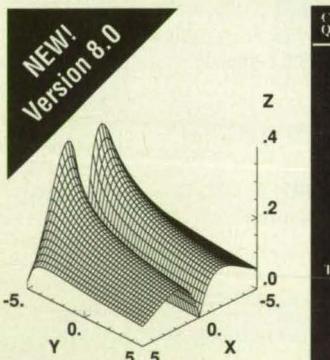
COMBAT
Computing the no-escape envelope of a short-range missile
Jul page 71 ARC-12404

COMBUSTION PRODUCTS
Mathematical model for deposition of soot
Aug page 49 MFS-28506

COMETARY ATMOSPHERES
Effects of multiple ion species on plasma instabilities
Jul page 50 NPO-17771

COMMAND AND CONTROL
Expert script generator
Oct page 70 LAR-14065

MATRIX_x is a registered trademark and SystemBuild is a trademark of Integrated Systems, Inc.



- ◆ NEW! Mouse-driven, hierarchical block diagram editor
- ◆ Dynamic Systems Modeling — linear, nonlinear, continuous, discrete, and hybrid
- ◆ SystemBuild for nonlinear systems simulation
- ◆ NEW! Extended memory support for faster simulations and larger models
- ◆ NEW! Robust Control and Optimization Modules available now on PCs



3260 Jay Street
Santa Clara, California 95054
Tel: (408) 980-1500
Fax: (408) 980-0400



Call for your
FREE Demo
Diskette
1-800-932-6284

1991 Annual Subject Index

COMMUNICATION

Optical receiver based on luminescent light trapping
Apr page 59 NPO-17916

COMMUNICATION NETWORKS

Quad-port transceivers for a dual-CRR LAN
Feb page 28 NPO-17541

COMMUNICATION SATELLITES

Estimating rain attenuation in satellite communication links
Dec page 48 LEW-14979

COMPENSATORS

Improved notch filter for synchronous-response control
Apr page 48 LAR-14173

COMPLEX SYSTEMS

Human error in complex systems
Apr page 101 ARC-12424

Decomposing systems into subsystems for design
Oct page 69 LAR-14210

COMPOSITE MATERIALS

Impact damage in carbon/epoxy and carbon/PEEK composites
Apr page 72 MFS-27245

Mixed-mode-bending delamination apparatus
Aug page 73 LAR-13985

Stiff, strong splice for a composite sandwich structure
Aug page 84 ARC-11743

Crack-free, nondistorting can for hot isostatic pressing
Oct page 98 LEW-14990

Crystalline imide/arylene ether copolymers
Oct page 47 LAR-14264

Imide/arylene ether copolymers
Dec page 44 LAR-14159

COMPOSITE STRUCTURES

Open-section composite structural elements
Feb page 45 MFS-26112

Composite struts would damp vibrations
Apr page 79 NPO-17914

Lightweight composite core for curved composite mirrors
Jun page 116 NPO-17858

Damping of vibrations in graphite/epoxy structures
Jul page 74 MFS-27228

Composite-material airflow vane
Sep page 108 LAR-14192

Development of composite panels for telescope mirrors
Oct page 100 NPO-17895

COMPRESSIBLE FLOW

Accounting for compressibility in viscous flow in pipes
Aug page 66 ARC-12249

COMPRESSOR BLADES

Measurements of boundary layers on a compressor blade
Apr page 83 LEW-14748

COMPRESSORS

Concentric regenerative sorption compressor
Jun page 100 NPO-17877

Sorption compressor with rotary regenerator
Jun page 101 NPO-17876

COMPUTATION

Library of subprograms in FORTRAN 77
Dec page 55 NPO-18120

COMPUTATIONAL FLUID DYNAMICS

Faster algorithm for computation of incompressible flow
Feb page 52 ARC-12370

Simulation of flow in a turbine cascade
Feb page 58 ARC-12551

Computational fluid dynamics in aerospace
Apr page 86 ARC-12107

Surface-shading program
May page 49 ARC-12381

Computing flow in a labyrinth seal
Jun page 98 MFS-29682

Generating three-dimensional grids about anything
Jun page 58 ARC-12620

Entropy-based approach to nonlinear stability
Jul page 76 ARC-12435

Streamwise algorithm for simulation of flow
Jul page 70 ARC-12718

Adaptive grids for computations of three-dimensional flows
Aug page 66 ARC-12479

Growth of instabilities in two types of mixing layers
Aug page 75 ARC-12567

Incompressible, viscous flow about an ogive/cylinder
Aug page 73 ARC-11793

Computed flow about the integrated space shuttle
Oct page 80 ARC-12685

Computed turbulent flow in a turnaround duct
Oct page 82 ARC-12552

Improved panel-method/potential-flow code
Oct page 66 ARC-12642

Numerical aerodynamic simulation program
Oct page 80 ARC-12245

Spectral method for simulation of vortex rings
Oct page 74 ARC-12639

Experiments to verify computed flows
Nov page 80 ARC-12231

Artificial intelligence in computational fluid dynamics
Dec page 73 ARC-12445

Computations of impulsively started viscous flow
Dec page 75 ARC-12382

COMPUTATIONAL GRIDS

Semiautomatic design of zonal computational grids
Feb page 52 ARC-12322

Generating three-dimensional grids about anything
Jun page 58 ARC-12620

COMPUTER PROGRAMS

Estimating the cost of developing software
Feb page 48 NPO-17936

Computation of flow in a turbine stage on a refined grid
Nov page 90 ARC-12444

Generation of surface grids from data points
Dec page 86 ARC-12481

COMPUTER AIDED DESIGN

Modifications of hydrostatic-bearing computer program
Apr page 89 MFS-29638

Computer-aided design of sheet-material parts
Aug page 83 MFS-29759

Computer language for optimization of design
Aug page 59 LAR-14280

Design and analysis of linear control systems
Aug page 59 KSC-11376

Software for design of life-support systems
Aug page 89 ARC-12665

Decomposing systems into subsystems for design
Oct page 69 LAR-14210

Numerical-optimization program
Dec page 57 LAR-14500

COMPUTER AIDED MAPPING

Program computes universal transverse Mercator projection
Jul page 62 NPO-18086

COMPUTER AIDED TOMOGRAPHY

Computed tomography for inspection of thermistors
Jun page 111 MFS-29642

Verifying x-radiographs with computed tomographs
Jun page 116 MFS-29649

COMPUTER COMPONENTS

Micro channel/Multibus-II interface circuit
Jul page 24 MSC-21506

Versatile, fast computer core
Sep page 50 GSC-13364

COMPUTER GRAPHICS

Program generates images of solid surfaces
Jan page 38 MSC-21630/49

Surface-shading program
May page 49 ARC-12381

Graphics software for VT terminals
Jul page 64 MFS-27214

Software package for real-time graphics
Jul page 32 ARC-12357

Graphical planning of spacecraft missions
Aug page 60 GSC-13318

Integrated analysis capability program
Dec page 54 GSC-13341

Software for depiction of three-dimensional objects
Dec page 55 MSC-21708

COMPUTER NETWORKS

Numerical aerodynamic simulation program
Oct page 80 ARC-12245

COMPUTER PROGRAMS

Estimating the cost of developing software
Feb page 48 NPO-17936

Do you need support for...

Ada? i860?

We Speak Your Language

QTC Math Library tools support many language environments, including FORTRAN, C, Ada, and i860 assembly. The software is available on over 40 platforms and over 10 operating systems. QTC has over 18,000 installations worldwide.



QTC leads the way in i860 support.

QTC, the first to announce a machine independent library for i860 developers.

qtc860 ADVANTAGE:

Over 80 hand-coded and optimized FFT, vector, image and signal processing routines for the i860. QTC has taken full advantage of the i860's pipeline architecture to provide optimum performance in a numerical package.

Ada MATH ADVANTAGE: With basic and complex math, eigensystems, FFTs, transcedentals, vector and matrix operations, full unsymmetric linear algebra, and many others, Ada Math Advantage enables you to easily code signal/image/seismic processing applications.

Ada MATH ADVANTAGE:

You simply use any of the routines as a "building block."

1 800 388 MATH

Quantitative Technology Corporation

8700 S.W. Creekside Place, Beaverton, OR 97005
(503) 626-3081 (617) 961-2700 Fax (503) 641-6012

QTC is a registered trademark of Quantitative Technology Corporation. Copyright © 1991. All rights reserved.

Circle Reader Action No. 633



When you're a million miles from home, you need materials you can count on . . .

...which is why Elgiloy® is the alloy of choice in a variety of aerospace applications.

But did you know we also offer over 40 nickel-based alloys in strip and wire? While we believe Elgiloy® is the answer to many needs, we also realize the importance of matching the right material to your specific requirements.

Call for a brochure with a complete listing of the alloys we offer.

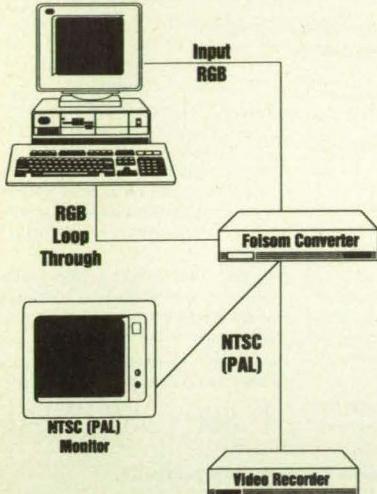
Exceptional Properties of Elgiloy®:

- ◆ High Strength
- ◆ Corrosion Resistant
- ◆ Excellent Fatigue Life
- ◆ Non-Magnetic
- ◆ Performs in Temperatures Ranging from -300° F to 850° F



ELGILOY® LIMITED PARTNERSHIP
1565 Fleetwood Drive Elgin, IL 60123 708/695-1900

Convert Any High-Res Video to TV Formats!



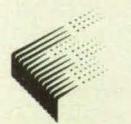
We Can Convert Anyone

With over 20 years experience, Folsom Research has built a worldwide reputation for superior products and leading-edge technology. Our products are currently used by most Fortune 500 companies.

Several models are available. Product features include

- Video frame grab.
- Digital frame buffer access.
- Support for multiple workstations.
- On-board V-LAN™ for controlling single-frame recorders, videodisks, and editing systems.
- Medical, video, and radar products available.

Call Us to Find Out Which Product Will Convert You!



526 East Bidwell Street
Folsom, CA 95630
tel: 916 983.1500
fax: 916.983.7236

- How safe is control software
Jun page 126 ARC-12710
- COMPUTER STORAGE DEVICES**
Deep FIFO surge buffer
May page 32 ARC-12159
- COMPUTER SYSTEMS PERFORMANCE**
Characterizing computers and predicting computing times
Sep page 60 ARC-12434
- COMPUTERIZED SIMULATION**
Displaying computer simulations of physical phenomena
Feb page 32 ARC-12502
- Computing rotational/vibrational dynamics of turbine engines
Mar page 42 LEW-14770
- Simulating the performance of a scramjet
Mar page 42 ARC-12338
- Simulating dynamics of the Gamma-Ray Observatory satellite
Apr page 76 GSC-13293
- High-resolution numerical simulation of shock waves
Jul page 74 ARC-11730
- Program for parallel discrete-event simulation
Nov page 69 NPO-18037
- Aid for simulating digital flight control systems
Dec page 56 ARC-11710/1
- Neural-network simulator
Dec page 48 MSC-21638
- Software for simulation of development of software
Dec page 56 NPO-18295
- CONCURRENT PROCESSING**
Program for parallel discrete-event simulation
Nov page 69 NPO-18037
- CONDUCTORS**
Testing conductive films for continuity
Feb page 41 NPO-17938
- Electrochemical deposition of conductive polymers
Apr page 64 NPO-17826
- Intramuscular contact lead filled with conductive solution
May page 74 NPO-17186
- CONFIDENCE**
Estimating confidence in data via trend analysis
Mar page 63 MFS-29710
- CONFIDENCE LIMITS**
Computing confidence limits
Mar page 46 MFS-29476
- Developing confidence limits for reliability of software
Nov page 102 LAR-14292
- CONJUGATE GRADIENT METHOD**
Conjugate gradient algorithms for manipulator simulation
Apr page 84 NPO-17929
- CONNECTORS**
Quick-connect truss fastener
Jul page 84 MSC-21504
- Quick-connect/disconnect joint for truss structures
Sep page 102 MSC-21539
- CONSTRAINTS**
Solving constraint-satisfaction problems in prolog language
Nov page 101 ARC-12460
- CONTACT RESISTANCE**
Flange correction for metal-to-metal contacts
May page 20 NPO-18052
- CONTAINERLESS MELTS**
Reducing thermal conduction in acoustic levitators
Jun page 120 NPO-17620
- Experiments on rotating, charged liquid drops
Jul page 49 NPO-17893
- Acoustic levitator with furnace and laser heating
Oct page 95 NPO-18035
- CONTAMINATION**
Pressure roller for tape-lift tests
Sep page 105 GSC-13230
- Contamination analysis program
Oct page 66 NPO-17982
- CONTOUR SENSORS**
Contact probe with pivoting tip
Nov page 77 MFS-28536
- CONTRAST**
Photorefractive crystal compresses dynamic range of image
Oct page 37 NPO-18098
- COOLING**
Stirling-cycle cooling for tunable diode laser
Aug page 16 NPO-18045
- Transpiration cooling of hypersonic blunt body
Aug page 57 ARC-12383
- Vaporization would cool primary battery
Sep page 90 NPO-17805
- COOLING SYSTEMS**
Garment would provide variable cooling
Jul page 44 MSC-21531
- COPOLYMERS**
Crystalline imide/arylene ether copolymers
Oct page 47 LAR-14264
- CONTROL**
Docking system with video feedback
Mar page 31 MFS-28421
- Active compliance and damping in telemannipulator control
Apr page 48 NPO-17969
- How safe is control software
Jun page 126 ARC-12710
- Design and analysis of linear control systems
Aug page 59 KSC-11376
- Research on controls and displays for V-STOL airplanes
Sep page 68 ARC-12215
- Analyzing control/structure interactions
Oct page 67 LEW-14904
- CONTROL EQUIPMENT**
Preventing aim at an undesired target
Aug page 24 NPO-18077
- Robot grasps rotating object
Sep page 58 NPO-18016
- Software for supervisory and shared control of a robot
Oct page 102 NPO-18116
- CONTROL SURFACES**
Placing control surfaces to suppress aeroelastic flutter
Jul page 71 ARC-12411
- CONTROLLERS**
Compact force-reflecting hand controller
Apr page 88 NPO-17851
- CONTROL SURFACES**
Leading-edge pop-up spoiler for airfoil
Mar page 52 LAR-13781
- CONNECTORS**
Quick-connect truss fastener
Jul page 84 MSC-21504
- Quick-connect/disconnect joint for truss structures
Sep page 102 MSC-21539
- COVARIANCE**
Generalized covariance analysis for remote estimates
Jan page 52 NPO-17824
- CONTROL THEORY**
State-variable representations for moving-average sampling
Jan page 48 MFS-28405
- Relative-error-covariance algorithms
Oct page 112 NPO-17956
- CRACK PROPAGATION**
Fatigue-crack-growth computer program
Apr page 74 MSC-21669
- CRACKING (FRACTURING)**
Grease inhibits stress-corrosion cracking in bearing race
Aug page 58 MFS-29664
- CREEP ANALYSIS**
Temperature, thermal stress, and creep in a structure
Nov page 81 ARC-12213
- CREW PROCEDURES (INFLIGHT)**
Flight checklists and interruptions
Mar page 68 ARC-12324
- CRYOGENIC EQUIPMENT**
Low-wear ball-bearing separator
Feb page 56 MFS-29666
- CRYOGENIC FLUIDS**
Improved ultrasonic transducer for measuring cryogenic flow
Nov page 78 MFS-29687
- CRYOGENICS**
Mechanically oriented, low-Curie-temperature materials
Apr page 71 MFS-26110
- Mixed-gas sorption Joule-Thomson refrigerator
May page 38 NPO-17569
- Concentric regenerative sorption compressor
Jun page 100 NPO-17877
- Performance of superconducting-cavity maser
Jun page 30 NPO-18175
- Test adapter for infrared detectors
Jul page 73 ARC-11389
- Improved gas-gap heat switch
Aug page 49 NPO-18136
- CRYSTAL GROWTH**
Modified furnace makes more silicon ribbon
Feb page 64 NPO-17350
- Electrostatic stabilization of growing protein crystals
Mar page 35 NPO-17747
- Improved boat for liquid-phase epitaxy
Jul page 80 LAR-14199
- Integrated protein-crystal-growing apparatus
Jul page 90 MFS-28422
- Thermosyphon suspension for growth of crystals
Jul page 82 MFS-26113
- Compact apparatus for growth of protein crystals
Aug page 51 MFS-28507
- Initiating growth of crystals away from container walls
Sep page 106 MFS-28473
- CRYSTALLINITY**
Correlating DSC and x-ray measurements of crystallinity
Sep page 77 NPO-17958
- CURIE TEMPERATURE**
Mechanically oriented, low-Curie-temperature materials
Apr page 71 MFS-26110

1991 Annual Subject Index

CUSHIONS

Thermal strap and cushion for thermoelectric cooler
Jun page 16 NPO-17806

CYBERNETICS

Orthogonal patterns in a binary neural network
May page 72 ARC-12454

D

DAMPERS (VALVES)

Model of bearing with hydrostatic damper
Jan page 43 MFS-29654

DAMPING

Bearing-cartridge damping seal
Aug page 77 MFS-29657

Damping seals would help support turbopump rotor
Aug page 77 MFS-27227

DATA ACQUISITION

System acquires and displays signal-propagation data
Sep page 64 NPO-18190

Program calibrates strain gauges
Dec page 52 MSC-21399

DATA CONVERTERS

Modular VLSI Reed-Solomon decoder
Sep page 49 NPO-17897

DATA PROCESSING

Optical backplane interconnection
Feb page 20 LAR-14052

Processor reforms data for transmission in bursts
Jun page 36 MSC-21727

Software package for real-time graphics
Jul page 32 ARC-12357

Hidden-Markov-model analysis of telemannipulator data
Oct page 87 NPO-18000

Algorithm derives rules from data
Nov page 96 NPO-18114

Study of candidate architectures for data processor
Nov page 48 MSC-21690

DATA RECORDERS

Sign-and-magnitude up/down counter
Oct page 24 NPO-17760

DATA REDUCTION

Dynacounter electronic data-reduction system
Nov page 46 MSC-21568

DATA RETRIEVAL

Systematic identification of discrepant hardware
Jun page 58 MFS-29525

Video image communication and retrieval—updated
Nov page 66 NPO-18076

DATA STORAGE

Deep FIFO surge buffer
May page 32 ARC-12159

DECODERS

Modular VLSI Reed-Solomon decoder
Sep page 49 NPO-17897

DECOMMUTATORS

System decommutes and displays telemetry data
Sep page 89 GSC-13324

DECONDITIONING

Physiology of prolonged bed rest
Mar page 68 ARC-12241

DEFECTS

Reactive fluorescent dyes for urethane coatings
Oct page 44 NPO-18038

DEFLECTION

Program analyzes errors in STAGS
Jan page 36 LAR-14063

DELAMINATING

Mixed-mode-bending delamination apparatus
Aug page 73 LAR-13985

DELTA WINGS

Computed hypersonic viscous flows over delta wings
Dec page 70 ARC-12179

DEMODULATORS

Resolving phase ambiguities in QPSK
Jul page 30 NPO-17853

DENSITY MEASUREMENT

Laser spectroscopic measurement of temperature and density
May page 43 ARC-12719

DEOXYGENATION

Copper-exchanged zeolite traps oxygen
Sep page 86 NPO-17761

DEOXYRIBONUCLEIC ACID

Environmental control of a genetic process
Jan page 54 NPO-17576

DEPOSITION

Coating solar cells by microwave plasma deposition
May page 60 NPO-17035

DEPOSITION

Preventing chemical-vapor deposition in selected areas
Jun page 122 LAR-14300

Deposition of diamondlike films by ECR microwave plasma
Oct page 42 NPO-18094

DESCENT

Simulation test of descent advisor
Jul page 36 ARC-12626

DESIGN ANALYSIS

Computer language for optimization of design
Aug page 59 LAR-14280

Decomposing systems into subsystems for design
Oct page 69 LAR-14210

Numerical-optimization program
Dec page 57 LAR-14500

Software-design-analyzer system
Dec page 57 NPO-18212

DESULFURIZING

Zeolites remove sulfur from fuels
Apr page 68 NPO-17480

DIAMONDS

Deposition of diamondlike films by ECR microwave plasma
Oct page 42 NPO-18094

Diamond-coated wire-feeding nozzle
Nov page 93 MFS-29714

DIAPHRAGMS (MECHANICAL)

Dual-diaphragm tank with leakage-indicating drain
Sep page 91 MSC-21703

DIATOMIC MOLECULES

Calculating electronic spectra of diatomic molecules
Oct page 41 ARC-12412

DIESEL FUELS

Zeolites remove sulfur from fuels
Apr page 68 NPO-17480

DIFFRACTION

Computing performance of an optical system
Jul page 60 GSC-13128

DIGITAL DATA

Processor reformats data for transmission in bursts
Jun page 36 MSC-21727

DIGITAL SYSTEMS

Electromagnetic interference in new aircraft
Aug page 32 ARC-12161

Programmable maintenance processor for XAIDS
Oct page 31 ARC-12164

Aid for simulating digital flight control systems
Dec page 56 ARC-11710/1

DIGITAL TECHNIQUES Simultaneous detection and estimation amid strong dynamical effects
Jan page 28 NPO-17820

Digital control of a telescope in an airplane
Aug page 29 ARC-12399

Digital image velocimetry
Oct page 78 ARC-12774

Matrix encoding for correction of errors
Oct page 108 NPO-17834

Multiple integrated in-line diode lasers
Nov page 34 LAR-14378

DIODES Low-loss coupler for microwave laser-diode modulation
Apr page 22 LAR-13788

Rugged direct-current transducer
Dec page 28 NPO-17957

DIRECTIONAL SOLIDIFICATION (CRYSTALS) Controlled temperature gradient improves freezing alloy
Sep page 83 MFS-28314

DISCONNECT DEVICES

Redundant toggle/hook release mechanism
Nov page 71 MSC-21671

DISPLAY DEVICES

Another program for generating interactive graphics
Jul page 65 GSC-13276

Helmet-mounted liquid-crystal display
Jul page 34 MSC-21460

Program for generating interactive displays
Jul page 64 GSC-13275

Effects of frame rates in video displays
Aug page 32 ARC-12358

Research on controls and displays for V/STOL airplanes

Sep page 68 ARC-12215

DISSIPATION

Artificial dissipation in computation of hypersonic flows
Jun page 124 ARC-12260

Extrema principles of dissipation in fluids
Jul page 48 ARC-12318

DISTRIBUTED FEEDBACK LASERS

Lateral-grating DFB laser
Mar page 22 LAR-13977

DISTRIBUTED PARAMETER SYSTEMS

Software for multivariable frequency-domain analysis
Sep page 87 LAR-14119/22

DISTRIBUTED PROCESSING

System for research on multiple-arm robots
Oct page 30 NPO-17971

DOCUMENTATION

Software-design-analyzer system
Dec page 57 NPO-18212

DOPPLER EFFECT

Behavior of Costas loop in reception of telemetry
Aug page 30 NPO-18084

Estimating SAR Doppler shifts from homogeneous targets
Oct page 102 NPO-17869

Estimating SAR Doppler shifts from quasi-homogeneous targets
Oct page 105 NPO-17905

XYZMAP

Full 3-D Digitizing and Mapping System

- Provides Forward and Reverse Zoom Functions
- Supports Scanner and Digitizer Input Devices
- Displays Quadrangle or Point and Radius Formats
- Includes XYZSPACE Spatial Database Engine

XYZSPACE

Multi-dimensional Spatial Database Engine

- Permits up to 30 Dimensions or Variables
- Cellular Multiresolution Capability
- Provides Natural Clustering of Information
- Address Radius, 50,000 KM by 10 Micron Precision



Available Platforms: 80486 Computers, Santa Cruz Operations & UNISYS, ESIX SVR4 UNIX Digital Equipment Corp's DEC 433 MP

XYZMAP & XYZSPACE are Reg. TM's of the XYZTEK Corp. UNIX is a Registered Trademark of AT&T Corp. 80486 is a Registered Trademark of the Intel Corp.

XYZTEK CORPORATION

5554 S. Prince St., Littleton, CO 80120 USA Tel: 303-850-9400

Circle Reader Action No. 377

Liquid Flowmeter; 0.1 to 100 ml/Min



\$3,150.

- No Moving Parts; Install Anywhere
- Not Affected By Vibration
- Bench, Pilot or Production Applications
- Catalyst and Nutrient Addition
- Batching, Flow Control & Totalizing
- Lotus Compatible RS-232 Output

M-Tek® • 2419 Smallman Street • Pittsburgh, PA 15222 USA
Phone: (800)245-5101 • (412)261-9030 • FAX: (412)261-7220

So Many Applications, Such Little Size...



Our new 768 x 493 resolution, full-function, 1/2" CCD cameras are so tiny there's no need for remoted imagers!

We've put it all in a package that you can hide in one hand. Using the highest resolution CCD in the popular 1/2" format, we created a series of extremely versatile miniature cameras. Four basic models offer features including externally controlled shuttering; asynchronous reset; external AGC, gamma and gain adjustments; standard C-mount; auto iris; external H/V sync; and single cable I/O.

And all at new, low pricing.

Our CCD cameras are made in the USA, and each comes with a full 3-year warranty. Contact the Video Products Division of PULNiX for complete information and the name of your nearest PULNiX sales representative.

- **TM-7CN**
All functions readily available on rear panel.
- **TM-7EX**
Same as TM-7CN except with addition of external sync.
- **TM-7**
Single cable I/O model for hostile environments or tamper defeat.
- **TM-7X**
Cylindrical version for reduced profile, pipe inspection, etc.
Single cable I/O only.

Note: All TM-7 series miniature cameras are available in CCIR (50Hz) models.

PULNiX

Video Products Division

PULNiX America, Inc.
770 Lucerne Drive
Sunnyvale, CA 94086
Tel: 408-733-1560
Fax: 408-737-2966

DOPPLER RADAR

Low-speed optical speedometer
Jun page 54 NPO-17702

Ambiguity of Doppler centroid in synthetic-aperture radar
Nov page 48 NPO-17943

DRAG

Crescent wing planforms reduce lift-dependent drag
Apr page 79 LAR-14015

DRAG REDUCTION

Polymers and riblets reduce hydrodynamic skin friction
Oct page 77 LAR-14271

Reducing water/hull drag by injecting air into grooves
Dec page 59 LAR-14078

DRILLS

Hand broaching tool for use in confined areas
Jun page 123 MFS-29669

DROPS (LIQUIDS)

Experiments on rotating charged liquid drops
Jul page 49 NPO-17893

Vapor-screen-density controller

Nov page 38 LAR-14099

DUCTS

Algebraic model of turbulence for internal flow
Aug page 63 ARC-12544

Computed turbulent flow in turnaround duct
Oct page 82 ARC-12552

Lightweight valve closes duct quickly
Dec page 64 MSF-28511

DYNAMIC CHARACTERISTICS
Simulating dynamics of the Gamma-Ray Observatory satellite
Apr page 76 GSC-13293

DYNAMIC LOADS

Improved computation of dynamic stresses
Jan page 39 MFS-29745

Calculating dynamics of helicopters and slung loads
Aug page 71 ARC-12755

DYNAMIC STRUCTURAL ANALYSIS
Dynamic analyses including joints of truss structures
Dec page 62 LAR-14306

DYNAMICAL SYSTEMS

Terminal attractors in neural networks
Jul page 89 NPO-17832

E

EARTH GRAVITATION

Computing gravitational bumps from repeating-orbit data
May page 52 NPO-17925

EARTH OBSERVING SYSTEM (EOS)

Spaceborne microwave imagers
Dec page 42 NPO-17094

EARTH RESOURCES SURVEY AIRCRAFT
Measuring wildfires from aircraft and satellites
Feb page 40 ARC-12132

EDDY CURRENT

Detecting filler spaces under tiles
May page 61 KSC-11411

EDDY CURRENTS

Noncontact measurements of torques in shafts
Mar page 50 MFS-29717

EDGES

Liquid-crystal light valve enhances edges in images
Apr page 54 NPO-17768

EDUCATION

Displaying computer simulations of physical phenomena
Feb page 32 ARC-12502

ELASTIC PROPERTIES

Triangular element for analyzing elasticity of laminates
Jul page 68 ARC-12534

ELASTIC WAVES

Software models impact stresses
Nov page 65 MFS-29628

ELASTOHYDRODYNAMICS

Lubrication of nonconformal contacts
Feb page 57 LEW-14882

ELASTOPLASTICITY

Program for elastoplastic analyses of plane frames
Aug page 59 LEW-14889

ELECTRIC BATTERIES

Reinforced positive filler paste for lead/acid batteries
Jan page 20 NPO-16991

Lightweight, high-energy lead/acid battery

Apr page 22 NPO-16962

Betavoltaics of increased power

Aug page 23 NPO-17817

Vaporization would cool primary battery

Sep page 90 NPO-17805

ELECTRIC BRIDGES

Thermocouple-signal-conditioning circuit
Jul page 20 MFS-29695

ELECTRIC CONNECTORS

Sealing out-of-round tubes with O-rings
Sep page 104 NPO-17791

ELECTRIC CONTACTS

Formation of ohmic contacts on epitaxial GaAs
Mar page 58 NPO-17795

Flange correction for metal-to-metal contacts

May page 20 NPO-18052

Intramuscular contact lead filled with conductive solution
May page 74 NPO-17186

ELECTRIC DISCHARGES

Electrical-discharge machining with additional axis
Feb page 63 MFS-29630

ELECTRIC FIELDS

Geographical variations in measured lightning fields
Sep page 78 KSC-11449

ELECTRIC MOTORS

Pulse-width-modulating driver for brushless dc motor
Sep page 18 NPO-17142

ELECTRIC WELDING

Magnetic deflection of welding electron beam
Apr page 94 MFS-29659

EDDY CURRENT

Tool for robotic resistive roll welding
May page 62 MFS-29660

1991 Annual Subject Index

Compact pinch welder Jun page 109 MFS-29670	ELECTRON BEAM WELDING Magnetic deflection of welding electron beam Apr page 94 MFS-29659	ETCHING Rapid dry etching of photoresists without toxic gases Jun page 104 ARC-11873	EYE (ANATOMY) Two-wavelength interferometric keratometer Feb page 39 NPO-17537	Alloy has high fatigue strength in hydrogen Nov page 62 MFS-28464	Effects of interference on scattering by parallel fibers Nov page 60 ARC-12530
Spot-welding gun is easy to use Jun page 119 MFS-29693	ELECTRONIC SPECTRA Calculating electronic spectra of diatomic molecules Oct page 41 ARC-12412	ETHYL ALCOHOL Manufacturing ethyl acetate from fermentation ethanol Sep page 84 NPO-17923	Computer-driven keratometer Sep page 118 NPO-17079	Dynacounter electronic data-reduction system Nov page 46 MSC-21568	FIELD EFFECT TRANSISTORS Dc-to-dc converter uses reverse conduction of MOSFET's Mar page 22 LEW-14944
Monitoring welding images and data simultaneously Aug page 29 MFS-29772	ELECTRO-OPTICS Electro-optical position-measuring system Jan page 26 LAR-13840	ETHYLENE OXIDE Apparatus circulates sterilizing gas Oct page 116 MSC-21552	Compensating for movement of eye in laser system Nov page 46 MSC-21509	FATIGUE TESTS Mode-II-fracture specimen and holder Apr page 80 LEW-14964	Stacked-gate FET's for analog memory elements Jul page 16 NPO-17627
ELECTRICAL MEASUREMENT Cross-quint-bridge resistor Jun page 28 NPO-18106	ELECTRICAL RESISTANCE Effects of moisture on zinc orthotitanate paint Mar page 41 NPO-17742	EULER EQUATIONS OF MOTION Using multiple grids to compute flows Mar page 37 ARC-12321	EYE DISEASES Portable video/digital retinal funduscope Sep page 115 MSC-21675	FAULT TOLERANCE Programs for modeling fault-tolerant computing systems Jan page 37 LAR-14165	Driver circuit for high-power MOSFET'S Nov page 28 LEW-15089
ELECTRICAL RESISTIVITY Measuring electrical resistivity of compacted powder Nov page 58 NPO-18056	ENERGY ABSORPTION Docking system would accommodate misalignments Aug page 68 MSC-21596	Calculation of aeroelastic transients using Euler equations May page 51 ARC-12351	EYE MOVEMENTS Instrument measures ocular counterrolling Dec page 91 MSC-21711	FEEDBACK Microwave oscillator would have reduced phase noise Jun page 20 NPO-17945	FILAMENT WINDING Filament winding of carbon/carbon structures Oct page 95 NPO-18163
ELECTROCHEMICAL CELLS Behavior of NbSe ₃ cathode in rechargeable Li cell Mar page 35 NPO-17648	ENERGY DISSIPATION External principles of dissipation in fluids Jul page 48 ARC-12318	EVALUATION Characterizing computers and predicting computing times Sep page 60 ARC-12434	F	FEEDBACK CONTROL Docking system with video feedback Mar page 31 MFS-28421	FILLERS High-temperature insulating gap filler Jul page 52 MSC-21644
ELECTRODES Lightweight fibrous Ni electrodes for Ni/H ₂ batteries Jul page 56 LEW-14955	ENGINE ANALYZERS Monitoring engine vibrations for spectrum of exhaust Dec page 79 MFS-29733	ENERGY DISSIPATION Human expertise helps computer classify images Oct page 110 MSC-21737	F-16 AIRCRAFT Transonic flows about a fighter airplane Oct page 79 ARC-12304	FEEDBACK CONTROL Salt filler for making covered channels Sep page 103 MFS-29729	SALT FILLER Salt filler for making covered channels Sep page 103 MFS-29729
Jointed holder for welding electrodes Nov page 95 MFS-29739	ENGINEERING MANAGEMENT Tracing and control of engineering requirements Dec page 56 NPO-18215	EVAPORATIVE COOLING Vaporization would cool primary battery Sep page 90 NPO-17805	FABRICATION Fabrication of ceramic mats Apr page 94 NPO-17210	FEEDBACK CONTROL More about video-feedback docking system Oct page 36 MFS-28419	FEEDERS Anthropomorphic remote manipulator Apr page 92 NPO-17975
ELECTROLYSIS Ionizable-substance detector Dec page 38 MFS-28515	ENVIRONMENTAL CONTROL Environmental control of a genetic process Jan page 54 NPO-17576	EXPERT SYSTEMS Parallel inferencing for rule-based expert systems Mar page 62 NPO-18004	FACTORIZATION QR factorization in the partial-realization problem Apr page 98 ARC-12284	FEEDBACK CONTROL R-parameterization of linear feedback systems Oct page 106 ARC-12369	FINITE DIFFERENCE THEORY Direct finite-difference simulators of turbulent flow Dec page 76 ARC-12463
ELECTROLYTES Lithium cells accept hundreds of recharges Jun page 28 NPO-17676	ENVIRONMENT POLLUTION Removing spilled oil with liquid nitrogen Mar page 38 LAR-14227	EVAPORATIVE COOLING Software for design of life-support systems Aug page 89 ARC-12665	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDBACK CONTROL Nonlinear dynamic compensation for feedback control Nov page 47 NPO-17993	FINITE ELEMENT METHOD Program analyzes errors in STAGS Jan page 36 LAR-14063
ELECTROLYTIC CELLS Making three-layer solid electrolyte/electrode sandwiches May page 67 NPO-17078	EPITAXY Improved boat for liquid phase epitaxy Jul page 80 LAR-14199	EXPERT SYSTEMS Intelligent computerized training system Oct page 107 MSC-21381	FEEDING (SUPPLYING) Diamond-coated wire-feeding nozzle Nov page 93 MFS-29714	FEEDERS Analyzing large reflector antenna structures Apr page 77 NPO-17783	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
Stacking oxygen-separation cells Jun page 118 NPO-17223	ENVIRONMENT POLLUTION Removing spilled oil with liquid nitrogen Mar page 38 LAR-14227	EXPERIMENTAL TRAINING Expert system for heat exchanger Oct page 90 NPO-17991	FAILURE ANALYSIS Phototransistors for long-wavelength infrared May page 26 NPO-18029	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Stress stiffening of STAR-DYNE plate elements Jul page 69 MFS-29738
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EPITAXY Improved boat for liquid phase epitaxy Jul page 80 LAR-14199	EXPERIMENTAL TRAINING Intelligent computerized training system Oct page 107 MSC-21381	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Manufacturing ethyl acetate from fermentation ethanol Sep page 84 NPO-17923	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROLYTIC CELLS Making three-layer solid electrolyte/electrode sandwiches May page 67 NPO-17078	EQUATIONS OF MOTION Efficient computation of inertia matrix of a manipulator May page 70 NPO-17545	EXPERIMENTAL TRAINING Parallel inferencing for rule-based expert systems Mar page 62 NPO-18004	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Nonlinear dynamic compensation for feedback control Nov page 47 NPO-17993	FINITE ELEMENT METHOD Analyzing large reflector antenna structures Apr page 77 NPO-17783
Stacking oxygen-separation cells Jun page 118 NPO-17223	ENVIRONMENT POLLUTION Removing spilled oil with liquid nitrogen Mar page 38 LAR-14227	EXPERIMENTAL TRAINING Software for design of life-support systems Aug page 89 ARC-12665	FAILURE ANALYSIS Phototransistors for long-wavelength infrared May page 26 NPO-18029	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EPITAXY Improved boat for liquid phase epitaxy Jul page 80 LAR-14199	EXPERIMENTAL TRAINING Intelligent computerized training system Oct page 107 MSC-21381	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EQUATIONS OF MOTION Efficient computation of inertia matrix of a manipulator May page 70 NPO-17545	EXPERIMENTAL TRAINING Parallel inferencing for rule-based expert systems Mar page 62 NPO-18004	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	ENVIRONMENT POLLUTION Removing spilled oil with liquid nitrogen Mar page 38 LAR-14227	EXPERIMENTAL TRAINING Software for design of life-support systems Aug page 89 ARC-12665	FAILURE ANALYSIS Phototransistors for long-wavelength infrared May page 26 NPO-18029	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EPITAXY Improved boat for liquid phase epitaxy Jul page 80 LAR-14199	EXPERIMENTAL TRAINING Intelligent computerized training system Oct page 107 MSC-21381	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EQUATIONS OF MOTION Efficient computation of inertia matrix of a manipulator May page 70 NPO-17545	EXPERIMENTAL TRAINING Parallel inferencing for rule-based expert systems Mar page 62 NPO-18004	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	ENVIRONMENT POLLUTION Removing spilled oil with liquid nitrogen Mar page 38 LAR-14227	EXPERIMENTAL TRAINING Software for design of life-support systems Aug page 89 ARC-12665	FAILURE ANALYSIS Phototransistors for long-wavelength infrared May page 26 NPO-18029	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EPITAXY Improved boat for liquid phase epitaxy Jul page 80 LAR-14199	EXPERIMENTAL TRAINING Intelligent computerized training system Oct page 107 MSC-21381	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EQUATIONS OF MOTION Efficient computation of inertia matrix of a manipulator May page 70 NPO-17545	EXPERIMENTAL TRAINING Parallel inferencing for rule-based expert systems Mar page 62 NPO-18004	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	ENVIRONMENT POLLUTION Removing spilled oil with liquid nitrogen Mar page 38 LAR-14227	EXPERIMENTAL TRAINING Software for design of life-support systems Aug page 89 ARC-12665	FAILURE ANALYSIS Phototransistors for long-wavelength infrared May page 26 NPO-18029	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EPITAXY Improved boat for liquid phase epitaxy Jul page 80 LAR-14199	EXPERIMENTAL TRAINING Intelligent computerized training system Oct page 107 MSC-21381	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EQUATIONS OF MOTION Efficient computation of inertia matrix of a manipulator May page 70 NPO-17545	EXPERIMENTAL TRAINING Parallel inferencing for rule-based expert systems Mar page 62 NPO-18004	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	ENVIRONMENT POLLUTION Removing spilled oil with liquid nitrogen Mar page 38 LAR-14227	EXPERIMENTAL TRAINING Software for design of life-support systems Aug page 89 ARC-12665	FAILURE ANALYSIS Phototransistors for long-wavelength infrared May page 26 NPO-18029	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EPITAXY Improved boat for liquid phase epitaxy Jul page 80 LAR-14199	EXPERIMENTAL TRAINING Intelligent computerized training system Oct page 107 MSC-21381	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EQUATIONS OF MOTION Efficient computation of inertia matrix of a manipulator May page 70 NPO-17545	EXPERIMENTAL TRAINING Parallel inferencing for rule-based expert systems Mar page 62 NPO-18004	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	ENVIRONMENT POLLUTION Removing spilled oil with liquid nitrogen Mar page 38 LAR-14227	EXPERIMENTAL TRAINING Software for design of life-support systems Aug page 89 ARC-12665	FAILURE ANALYSIS Phototransistors for long-wavelength infrared May page 26 NPO-18029	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EPITAXY Improved boat for liquid phase epitaxy Jul page 80 LAR-14199	EXPERIMENTAL TRAINING Intelligent computerized training system Oct page 107 MSC-21381	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EQUATIONS OF MOTION Efficient computation of inertia matrix of a manipulator May page 70 NPO-17545	EXPERIMENTAL TRAINING Parallel inferencing for rule-based expert systems Mar page 62 NPO-18004	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	ENVIRONMENT POLLUTION Removing spilled oil with liquid nitrogen Mar page 38 LAR-14227	EXPERIMENTAL TRAINING Software for design of life-support systems Aug page 89 ARC-12665	FAILURE ANALYSIS Phototransistors for long-wavelength infrared May page 26 NPO-18029	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EPITAXY Improved boat for liquid phase epitaxy Jul page 80 LAR-14199	EXPERIMENTAL TRAINING Intelligent computerized training system Oct page 107 MSC-21381	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EQUATIONS OF MOTION Efficient computation of inertia matrix of a manipulator May page 70 NPO-17545	EXPERIMENTAL TRAINING Parallel inferencing for rule-based expert systems Mar page 62 NPO-18004	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	ENVIRONMENT POLLUTION Removing spilled oil with liquid nitrogen Mar page 38 LAR-14227	EXPERIMENTAL TRAINING Software for design of life-support systems Aug page 89 ARC-12665	FAILURE ANALYSIS Phototransistors for long-wavelength infrared May page 26 NPO-18029	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EPITAXY Improved boat for liquid phase epitaxy Jul page 80 LAR-14199	EXPERIMENTAL TRAINING Intelligent computerized training system Oct page 107 MSC-21381	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EQUATIONS OF MOTION Efficient computation of inertia matrix of a manipulator May page 70 NPO-17545	EXPERIMENTAL TRAINING Parallel inferencing for rule-based expert systems Mar page 62 NPO-18004	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	ENVIRONMENT POLLUTION Removing spilled oil with liquid nitrogen Mar page 38 LAR-14227	EXPERIMENTAL TRAINING Software for design of life-support systems Aug page 89 ARC-12665	FAILURE ANALYSIS Phototransistors for long-wavelength infrared May page 26 NPO-18029	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EPITAXY Improved boat for liquid phase epitaxy Jul page 80 LAR-14199	EXPERIMENTAL TRAINING Intelligent computerized training system Oct page 107 MSC-21381	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EQUATIONS OF MOTION Efficient computation of inertia matrix of a manipulator May page 70 NPO-17545	EXPERIMENTAL TRAINING Parallel inferencing for rule-based expert systems Mar page 62 NPO-18004	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	ENVIRONMENT POLLUTION Removing spilled oil with liquid nitrogen Mar page 38 LAR-14227	EXPERIMENTAL TRAINING Software for design of life-support systems Aug page 89 ARC-12665	FAILURE ANALYSIS Phototransistors for long-wavelength infrared May page 26 NPO-18029	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EPITAXY Improved boat for liquid phase epitaxy Jul page 80 LAR-14199	EXPERIMENTAL TRAINING Intelligent computerized training system Oct page 107 MSC-21381	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EQUATIONS OF MOTION Efficient computation of inertia matrix of a manipulator May page 70 NPO-17545	EXPERIMENTAL TRAINING Parallel inferencing for rule-based expert systems Mar page 62 NPO-18004	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	ENVIRONMENT POLLUTION Removing spilled oil with liquid nitrogen Mar page 38 LAR-14227	EXPERIMENTAL TRAINING Software for design of life-support systems Aug page 89 ARC-12665	FAILURE ANALYSIS Phototransistors for long-wavelength infrared May page 26 NPO-18029	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EPITAXY Improved boat for liquid phase epitaxy Jul page 80 LAR-14199	EXPERIMENTAL TRAINING Intelligent computerized training system Oct page 107 MSC-21381	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	EQUATIONS OF MOTION Efficient computation of inertia matrix of a manipulator May page 70 NPO-17545	EXPERIMENTAL TRAINING Parallel inferencing for rule-based expert systems Mar page 62 NPO-18004	FAILURE ANALYSIS Probabilistic/fracture-mechanics model for service life Jul page 77 MFS-27237	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC ABSORPTION Optical receiver based on luminescent light trapping Apr page 59 NPO-17916	ENVIRONMENT POLLUTION Removing spilled oil with liquid nitrogen Mar page 38 LAR-14227	EXPERIMENTAL TRAINING Software for design of life-support systems Aug page 89 ARC-12665	FAILURE ANALYSIS Phototransistors for long-wavelength infrared May page 26 NPO-18029	FEEDERS Salt filler for making covered channels Sep page 103 MFS-29729	FINITE ELEMENT METHOD Calculating transient vibrations of coupled substructures May page 54 MFS-28477
ELECTROMAGNETIC					

FLEXIBLE SPACECRAFT	Navier-Stokes simulation of wind-tunnel flow	FLUID FLOW	FRAMES (DATA PROCESSING)	GAMMA RAYS	GENITOURINARY SYSTEM
Zero-spring-rate mechanism/air suspension cart	Oct page 85 ARC-12193	High-resolution computations of hypersonic flows	Effects of frame rates in video displays	Microscope would image x and γ rays	Ultrasonic device monitors fullness of the bladder
Aug page 69 LAR-14142		Feb page 57 ARC-12254	Aug page 32 ARC-12358	Sep page 71 MFS-28484	Sep page 115 LAR-13689
FLIGHT CHARACTERISTICS	Numerical aerodynamic simulation program	External principles of dissipation in fluids	FREQUENCY ANALYZERS	GAMMA RAY TELESCOPES	GEODESY
Computing the dynamics of helicopters	Oct page 80 ARC-12245	Jul page 48 ARC-12318	Two-dimensional acousto-optical spectrum analyzer	Telescope would image x and γ rays	Estimating baselines from constrained data on GPS orbits
Feb page 46 ARC-12337	Speeding convergence in simulations of hypersonic flow	Improved ultrasonic transducer for measuring cryogenic flow	Sep page 72 NPO-18092	Sep page 70 MFS-28482	Nov page 40 NPO-18173
Computing linear mathematical models of aircraft	Oct page 82 ARC-12601	Nov page 78 MFS-29687	FREQUENCY STANDARDS	GARMENTS	GEOMETRICAL OPTICS
Mar page 45 ARC-12422	Computation of flow in a turbine stage on a refined grid	FLUIDIZED BED PROCESSORS	Trapped-mercury-ion frequency standard	Garment would provide variable cooling	Computing performance of an optical system
Surface-shading program	Nov page 90 ARC-12444	Fluidized-bed silane-decomposition reactor	Jun page 55 NPO-17456	Jul page 44 MSC-21531	Jul page 60 GSC-13128
May page 49 ARC-12381	A general-coordinate formulation for boundary-layer flow	Nov page 63 NPO-18014	FREQUENCY SYNCHRONIZATION	GAS CHROMATOGRAPHY	GEOTHERMAL ENERGY UTILIZATION
Software package for real-time graphics	Dec page 59 ARC-12465	FLUORESCENCE	Diplex fiber-optic link for frequency and time signals	GC/MS gas separator operates at lower temperatures	Vapor-resistant heat-pipe artery
Jul page 32 ARC-12357	Mathematical models of turbulence in hypersonic flow	Reactive fluorescent dyes for urethane coatings	Jun page 39 NPO-18180	Jun page 50 NPO-17930	Jun page 61 MSC-21492
FLIGHT CONTROL	Dec page 67 ARC-12609	Oct page 44 NPO-18038	FRICITION MEASUREMENT	GAS DISSOCIATION	GERMINATION
Aid for simulating digital flight control systems	FLOW MEASUREMENT	FLUTTER	Measuring adhesion and friction forces	Effects of molecular processes on trim angles	Capillary-effect root-environment system
Dec page 56 ARC-11710/1	Measurements of boundary layers on a compressor blade	Placing control surfaces to suppress aeroelastic flutter	Jan page 39 LEW-14903	Apr page 62 ARC-12566	Dec page 92 KSC-11350
FLIGHT ENVELOPES	Apr page 83 LEW-14748	Jul page 71 ARC-12411	FUEL CELLS	GAS DYNAMICS	GIMBALS
Computing the no-escape envelope of a short-range missile	FLOW REGULATORS	Flutter spoilers	Making three-layer solid electrolyte/electrode sandwiches	High-resolution numerical simulation of shock waves	Unbalanced rotating masses for scanning
Jul page 71 ARC-12404	Pressure-actuated flow-control valve	Sep page 93 LAR-14117	May page 67 NPO-17078	Jul page 74 ARC-11730	Sep page 100 MFS-28425
FLIGHT MANAGEMENT SYSTEMS	Nov page 74 MFS-28513	FOREST FIRES	GAS FLOW	GAS FLOW	Flexure bearing reduces startup friction
Knowledge-based flight-status-monitor	FLOW STABILITY	Measuring wildfires from aircraft and satellites	High-resolution computations of hypersonic flows	Nov page 72 LAR-14348	
Dec page 31 ARC-12712	Growth of instabilities in two types of mixing layers	Feb page 40 ARC-12132	Feb page 57 ARC-12254		
FLIGHT OPERATIONS	Aug page 75 ARC-12567	FORMING TECHNIQUES	GAS LASERS	GLARE	
Flight checklists and interruptions	FLOW VELOCITY	Multipiece mandrel for spray-forming complex parts	Automatic rejection of multimode laser pluses	Variable-vision sun visor	
Mar page 68 ARC-12324	New sensors for flow velocity and acoustics	Mar page 57 MFS-29680	Dec page 24 NPO-1777	Jul page 44 LAR-14147	
FLIGHT PATHS	Dec page 76 ARC-12577	FORTRAN	GAS SPECTROSCOPY	GLOBAL POSITIONING SYSTEM	
Simulation test of descent advisor	FLOW VISUALIZATION	Source-code-analyzing program	Computer processing of tunable-diode-laser spectra	Digital accumulators in phase- and frequency-tracking loops	
Jul page 36 ARC-12626	Point-diffraction interferometer for flow experiments	Mar page 46 GSC-13268	May page 28 NPO-18019	Aug page 30 NPO-17909	
FLIGHT SAFETY	Mar page 34 ARC-12489	FUNCTIONS (MATHEMATICS)	GAS TUNGSTEN ARC WELDING	GLOMUS DETECTOR CELLS	
Estimating atmospheric turbulence from flight records	Twin-mirrored galvanometer laser-light-sheet generator	Recursive inversion by finite-impulse-response filters	Fast, nonspattering inert-gas welding	Characterization of electrical response of photodetector	
Jul page 45 ARC-12589	May page 30 LAR-14248	Graphics software for VT terminals	Feb page 61 MFS-29648	Dec page 24 GSC-13349	
FLIGHT SIMULATION	Aug page 65 LAR-14342	Jul page 64 MFS-27214	Compact gas/tungsten arc welding torch	Estimating baselines from constrained data on GPS orbits	
Computer simulation of a small turboshaft engine	Digital image velocimetry	Characterizing computers and predicting computing times	Jun page 108 MFS-29668	Nov page 40 NPO-18173	
Mar page 55 ARC-12299	Nov page 96 ARC-12474	Sep page 60 ARC-12434	Self-aligning sensor-mounting fixture		
FLIGHT STRESS (BIOLOGY)	Vapor-screen-density controller	Library of subprograms in FORTRAN 77	Jun page 107 MFS-29663		
More life-science experiments for Spacelab	Nov page 38 LAR-14099	Dec page 55 NPO-18120	G		
Apr page 102 ARC-12316	Processing particles-streak imagery on a personal computer	Graphics software for VT terminals	GALLIUM ARSENIDES		
FLOW DISTRIBUTION	Dec page 69 ARC-12267	Jul page 64 MFS-27214	V-grooved GaAs solar cell		
Streamwise algorithm for simulation of flow	FTIR spectroscopic characterization of II-VI superconductors	Feb page 16 LEW-14954	Feb page 16 MSC-21473		
Jul page 70 ARC-12718	Apr page 55 MFS-27234	Jan page 52 ARC-12295	Formation of ohmic contacts on epitaxial GaAs		
Helicity-density and normalized-helicity maps of flows	Transferring functions via Laplace- and Fourier-Borel transforms	FTIR spectroscopic characterization of II-VI superconductors	Mar page 58 NPO-17795		
Aug page 62 ARC-12464	Sep page 112 ARC-12295	Apr page 24 GSC-13205	Improved planar Schottky diode		
Improved panel-method/potential-flow code	Characterization of electrical response of photodetector	Alternative Al _x Ga _{1-x} As/GaAs transistors for neural networks			
Oct page 66 ARC-12642	Dec page 24 GSC-13349	Sep page 26 NPO-18177	Smaller coaxial-view welding torch		
FLOW EQUATIONS	Simulations of flow in a turbine cascade	High-gain Al _x Ga _{1-x} As/GaAs transistors for neural networks	Dec page 82 MFS-29744		
Using multiple grids to compute flows	Feb page 58 ARC-12551	Sep page 24 NPO-18101	GASKETS		
Mar page 37 ARC-12321	Overview of aerothermodynamics of hypersonic flight	FRACTURE MECHANICS	Long-lived, replaceable low-pressure seals		
Artificial dissipation in computation of hypersonic flows	Jul page 51 ARC-12217	Fatigue-crack-growth computer program	Sep page 98 MFS-28521		
Jun page 124 ARC-12260	Adaptive grids for computations of three-dimensional flows	Apr page 74 MSC-21669	GATES (CIRCUITS)		
Entropy-based approach to nonlinear stability	Aug page 66 ARC-12479	Probabilistic/fracture-mechanics model for service life	Associative-memory array of optical logic gates		
Jul page 76 ARC-12435	Experiments to verify computed flows	Jul page 77 MFS-27237	May page 30 NPO-17997		
Algebraic model of turbulence for internal flow	Nov page 80 ARC-12231	FRACTURES (MATERIALS)	GEARS		
Aug page 63 ARC-12544	Artificial intelligence in computational fluid dynamics	Mode-II-fracture specimen and holder	"Bearingless" bull gear		
Computed turbulent flow in a turn-around duct	Dec page 73 ARC-12445	Apr page 80 LEW-14964	Apr page 90 LEW-14911		
		FRAMES	Torque-splitting gear drive		
		Program for elastoplastic analyses of plane frames	Apr page 90 LEW-14908		
		Aug page 59 LEW-14889	GENE EXPRESSION		
			Cloned hemoglobin genes enhance growth of cells		
			Jan page 54 NPO-17517		
			Environmental control of a genetic process		
			Jan page 54 NPO-17576		
			Environmental control of a genetic process		
			Jan page 54 NPO-17576		

Jul page 84 MFS-28452	Vapor-resistant heat-pipe artery	HIGH TEMPERATURE SUPERCONDUCTORS
GROUND BASED CONTROL	Jun page 61 MSC-21492	Forming $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ superconductors on copper substrates
Knowledge-based flight-status monitor	Heat-transfer coupling for heat pipes	Mar page 38 KSC-11448
Dec page 31 ARC-12712	Sep page 92 NPO-17863	Passivation of high-temperature superconductors
GUIDANCE (MOTION)	HEAT PUMPS	Apr page 69 NPO-17949
Back azimuth guidance in departures and missed approaches	Nonazeotropic heat pump	
Jul page 39 ARC-12611	Mar page 51 MFS-26099	
GYROSCOPES	HEAT SHIELDING	
Block Lanczos algorithm for gyroscopic systems	Tests of flexible multilayer insulations	
Aug page 75 ARC-12147	Jul page 58 ARC-12405	
H	HEAT SINKS	
HALL EFFECT	Effects of heat sinks on VPPA welds	
Magnet/Hall-effect random-access memory	Oct page 99 MFS-27240	
Nov page 28 NPO-17999	HEAT TAPES	
Rugged direct-current transducer	Casting of multilayer ceramic tapes	
Dec page 28 NPO-17957	Jun page 110 NPO-17166	
HAND (ANATOMY)	HEAT TRANSFER	
Prosthetic hand lifts heavy loads	Oscillating thermal switch	
Feb page 69 MFS-28465	Feb page 34 NPO-17125	
Rotationally actuated prosthetic hand	High-power liquid-metal heat-transfer loop	
Feb page 69 MFS-28426	May page 35 NPO-18034	
Direct-link prehensor	Effects of interference on scattering by parallel fibers	
Dec page 78 ARC-11666	Nov page 60 ARC-12530	
HANDLING EQUIPMENT	HELICOPTER CONTROL	
Quick-acting closure and handling system	Precise autohover control for helicopter	
Mar page 54 LAR-13774	Oct page 36 ARC-12243	
Heavy-workpiece handler for vacuum plasma spraying	HELICOPTER PERFORMANCE	
Oct page 99 MFS-28522	Computing the dynamics of helicopters	
HANKEL FUNCTIONS	Feb page 46 ARC-12337	
QR factorization in the partial-realization problem	Computer simulation of a small turboshaft engine	
Apr page 98 ARC-12284	Mar page 55 ARC-12299	
HARDWARE UTILIZATION LISTS	Calculating dynamics of helicopters and slung loads	
Systematic identification of discrepant hardware	Aug page 71 ARC-12755	
Jun page 58 MFS-29525	HELICOPTERS	
HARMONIC GENERATORS	"Bearingless" ball gear	
Organometallic salts generate optical second harmonics	Apr page 90 LEW-14911	
Jun page 54 NPO-17730	Calculating flow through a helicopter rotor	
HEART	May page 55 ARC-12202	
Numerical simulation of flow through an artificial heart	Research in helicopter noise	
Dec page 66 ARC-12478	Aug page 74 ARC-12171	
HEAT EXCHANGERS	HELMET MOUNTED DISPLAYS	
Two-phase bidirectional heat exchanger	Helmet-mounted liquid-crystal display	
Mar page 49 GSC-13287	Jul page 34 MSC-21460	
Salt filler for making covered channels	HELMETS	
Sep page 103 MFS-29729	Protecting helmets and visors from chemicals	
Expert system for heat exchanger	Apr page 70 MSC-21503	
Oct page 90 NPO-17991	HEMOGLOBIN	
HEAT FLUX	Cloned hemoglobin genes enhance growth of cells	
Integral plug-type heat-flux gauge	Jan page 54 NPO-17517	
Aug page 72 LEW-14967	Computation of facilitated transport of O_2 in hemoglobin	
HEAT OF FUSION	Jun page 128 ARC-12417	
Correlating DSC and x-ray measurements of crystallinity	HIGH LEVEL LANGUAGES	
Sep page 77 NPO-17958	General-purpose Ada software packages	
HEAT PIPES	Feb page 51 NPO-17983	
Higher-performance ambient-temperature heat pipe	Ada nameelist package	
May page 57 MSC-21515	May page 50 NPO-17984	
HIGH PASS FILTERS	HIGH TEMPERATURE SUPERCONDUCTORS	
Making high-pass filters for submillimeter waves	Forming $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ superconductors on copper substrates	
Aug page 83 NPO-17992	Passivation of high-temperature superconductors	
HIGH STRENGTH	Apr page 69 NPO-17949	
High-strength fiber composite		
Oct page 90 NPO-17993	HORN ANTENNAS	
HOSES	Megawatt square microwave feed horn	
Rotary coupling extends life of hose	Jun page 22 NPO-18025	
HOUSINGS	HOLES	
Laser welding of contoured thin-wall housings	Rotary coupling extends life of hose	
Mar page 57 MFS-29653	Mar page 49 GSC-13316	
HOVERING	HOT-FILM ANEMOMETERS	
Precise autohover control for a helicopter	Laminar-separation sensor	
Oct page 36 ARC-12243	Mar page 50 LAR-14314	
HOUSEKEEPING (SPACECRAFT)	HOT ISOSTATIC PRESSING	
Dishwasher for Earth or outer space	Crack-free, nondistorting can for hot isostatic pressing	
Jul page 78 MSC-21442	Oct page 98 LEW-14990	
HOUSINGS	HOUSEKEEPING (SPACECRAFT)	
Laser welding of contoured thin-wall housings	Dishwasher for Earth or outer space	
Mar page 57 MFS-29653	Jul page 78 MSC-21442	
HOVERING	HOUSINGS	
Precise autohover control for a helicopter	Laser welding of contoured thin-wall housings	
Oct page 36 ARC-12243	Mar page 57 MFS-29653	
HUMAN FACTORS ENGINEERING	HOVERING	
YAMM—yet another menu manager	Precise autohover control for a helicopter	
Feb page 47 NPO-17769	Oct page 36 ARC-12243	
HUMAN PERFORMANCE	HUMAN FACTORS ENGINEERING	
Human error in complex systems	YAMM—yet another menu manager	
Apr page 101 ARC-12424	Feb page 47 NPO-17769	
HUMAN TOLERANCES	HUMAN TOLERANCES	
Effect of bed rest on tolerance to acceleration	Effect of bed rest on tolerance to acceleration	
Mar page 68 ARC-12400	Mar page 68 ARC-12400	
HYDROGEN	HYDROGEN	
Real-gas properties of air and air-plus-hydrogen mixtures	Real-gas properties of air and air-plus-hydrogen mixtures	
Jan page 30 ARC-12275	Jan page 30 ARC-12275	
HYDROGEN EMBRITTLEMENT	HYDROGEN EMBRITTLEMENT	
Alloy has high fatigue strength in hydrogen	Alloy has high fatigue strength in hydrogen	
Nov page 62 MFS-28464	Nov page 62 MFS-28464	
HYDROPONICS	HYDROPONICS	
Closed-cycle nutrient supply for hydroponics	Closed-cycle nutrient supply for hydroponics	
Jul page 90 MSC-21655	Jul page 90 MSC-21655	
HYDROSTATIC	HYDROSTATIC	
Modifications of hydrostatic-bearing computer program	Modifications of hydrostatic-bearing computer program	
Apr page 89 MFS-29638	Apr page 89 MFS-29638	

GUIDE TO NOISE CONTROL. FREE.

This brochure gives you detailed information about the industry's finest noise killers—SONEX acoustical sheets, baffles and ceiling tiles. For your free copy, use the reader service number below. Or call this number toll-free today. 1-800-662-0032.

illbruck

© 1991, illbruck, inc.

Circle Reader Action No. 466

Now you can accurately measure temperature from -50°C to 3500°C without contact!



Choose from two new Mikron infrared temperature transmitters - the M210LS or the M77LS - specifically designed for research and laboratory applications. Their through-lens sighting and variable focussing features permit precision pinpointing of the target area.

M210LS is a broad temperature range system covering temperatures from -50°C to 2500°C. The M77LS transmitter is a high temperature 2-color instrument that is independent of emissivity and covers ranges from 550°C to 3500°C.

Both systems are available with an auxiliary electronics processing module, or can be connected to your existing controls. Send today for more information.

MIKRON®

MIKRON INSTRUMENT COMPANY, INC.

445 W. Main St., Wyckoff, NJ 07481 U.S.A.

Tel. 201-891-7330 • FAX: 201-891-1205

TELEX: 361870 • TOLL FREE HOT-LINE: 800-631-0176

Circle Reader Action No. 390

HYPERBOLIC DIFFERENTIAL EQUATIONS

Overview of methods for computation of shocks
Jul page 74 ARC-12667

HYPersonic FLIGHT

Effects of molecular processes on trim angles
Apr page 62 ARC-12566

Overview of aerothermodynamics of hypersonic flight
Jul page 51 ARC-12217

Aerodynamics of missiles: present and future
Oct page 83 ARC-12188

HYPersonic FLOW

High-resolution computations of hypersonic flows
Feb page 57 ARC-12254

Artificial dissipation in computation of hypersonic flows
Jun page 124 ARC-12260

Algorithm computes hypersonic flow of air
Sep page 76 ARC-12623

Computed hypersonic flow about a sharp cone
Oct page 85 ARC-12675

Speeding convergence in simulations of hypersonic flow
Oct page 82 ARC-12601

Computed hypersonic viscous flows over delta wings
Dec page 70 ARC-12179

Mathematical models of turbulence in hypersonic flow
Dec page 67 ARC-12609

HYPersonic VEHICLES

Transpiration cooling of hypersonic blunt body
Aug page 57 ARC-12383

HYPersonic WIND TUNNELS

Laser spectroscopic measurement of temperature and density
May page 43 ARC-12719

Adjustable pitot probe
Aug page 70 LAR-14232

HYPERVERELOCITY LAUNCHERS

Superconducting magnetic projectile launcher
Mar page 48 NPO-17746

I**IBM COMPUTERS**

Micro channel/Multibus-II interface circuit
Jul page 24 MSC-21506

IMAGE ANALYSIS

Human expertise helps computer classify images
Oct page 110 MSC-21737

Digital image velocimetry
Nov page 96 ARC-12474

IMAGE ENHANCEMENT

Liquid-crystal light valve enhances edges in images
Apr page 54 NPO-17768

IMAGE PROCESSING

Displaying images of planets
Jun page 57 NPO-17977

Improved remapping processor for digital imagery
Jul page 26 MSC-21481

Detection of motion with a phase-conjugate mirror
Oct page 40 NPO-17784

Digital image velocimetry
Oct page 78 ARC-12774

Improved interferometric photorefractive optical processor
Oct page 39 NPO-17773

Photorefractive crystal compresses dynamic range of image
Oct page 37 NPO-18098

Video image communication and retrieval—updated
Nov page 66 NPO-18076

Processing particles-streak imagery on a personal computer
Dec page 69 ARC-12267

Program Processes SAR data
Dec page 52 NPO-18048

Half-tone video images of drifting sinusoidal gratings
Apr page 46 ARC-12414

IMAGING RADAR
Status of imaging radar polarimetry
Jan page 30 NPO-17890

Improved radiometric correction for SAR images
Oct page 37 NPO-17931

IMAGING TECHNIQUES
Heterojunction-internal-photoemission infrared detectors
Jan page 22 NPO-17879

Imaging microscope for "water-window" x rays
Jul page 40 MFS-28485

Video recording of images in laser remote sensing
Jul page 26 GSC-13398

Monitoring welding images and data simultaneously
Aug page 29 MFS-29772

Spatial light modulator would serve as electronic iris
Aug page 22 MFS-29758

Low-noise charge-coupled device
Oct page 20 NPO-18031

Altering interline transfer in a CCD to reduce saturation
Dec page 30 NPO-17935

IMIDES
New synthesis of high-performance bismaleimides
Jul page 54 LAR-13958

IMPACT LOANS
Software models impact stresses
Nov page 65 MFS-29628

IMPACT TESTS
Impact damage in carbon/epoxy and carbon/PEEK composites
Apr page 72 MFS-27245

INCOMPRESSIBLE FLUIDS
Pressure fluctuations in simulated turbulent channel flow
Oct page 80 ARC-12597

INCOMPRESSIBLE FLOW
Faster algorithm for computation of incompressible flow
Feb page 52 ARC-12370

Improved remapping processor for digital imagery
Jul page 26 MSC-21481

Incompressible, viscous flow about an ogive/cylinder
Aug page 73 ARC-11793

Methods of simulation of incompressible flow
Dec page 74 ARC-12199

INDUCTORS
Spacing windings evenly in toroidal inductors
May page 69 NPO-17830

INDUSTRIAL MANAGEMENT
Tracing and control of engineering requirements
Dec page 56 NPO-18215

INERT ATMOSPHERE
Trailing shield for welding on pipes
Dec page 82 MFS-29743

INFERENCE
Parallel inferencing for rule-based expert systems
Mar page 62 NPO-18004

INFORMATION PROCESSING (BIOLOGY)
Processing of visual information in primate brains
Mar page 67 NPO-17900

INFORMATION THEORY
Algorithm derives rules from data
Nov page 96 NPO-18114

INFRARED DETECTORS
Heterojunction-internal-photoemission infrared detectors
Jan page 22 NPO-17879

INTEGRATED CIRCUITS
Multiple-quantum-well intersubband infrared detector
Jan page 25 NPO-17962

Phototransistors for long-wavelength infrared
May page 26 NPO-18029

Test adapter for infrared detectors
Jul page 73 ARC-11389

Hole-impeded-doping-superlattice LWIR detectors
Sep page 22 NPO-17880

Ir/IrSi₃/Si Schottky-barrier infrared detector
Oct page 22 NPO-18144

Si_{1-x}Ge_x/Si infrared photodiodes
Oct page 26 NPO-17950

Proceedings of infrared-detector workshop
Nov page 60 ARC-12851

Si/IrSi₃ Schottky-barrier infrared detectors
Dec page 22 NPO-18027/17946

INFRARED IMAGERY
Estimating the SNR of AVIRIS data
Feb page 66 ARC-12361

INFRARED SPECTROSCOPY
FTIR spectroscopic characterization of II-VI superconductors
Apr page 55 MFS-27234

Stirling-cycle cooling for tunable diode laser
Aug page 16 NPO-18045

INJECTION LASERS
Self-injection locking of diode lasers
Jun page 46 NPO-17665

INJECTORS

Vacuum powder injector
Oct page 93 LAR-14179

INSPECTION

Improved metallography of thermal-barrier coatings
Apr page 56 LEW-15006

INDUCTORS

Flexible interior-impression-molding tray
May page 63 MFS-29579

INDUSTRIAL MANAGEMENT

Penetrant-indication-measuring compass
Jun page 110 MFS-29643

INSTRUMENT COMPENSATION

Computerized profilometer for inspection of welds
Aug page 79 MFS-28548

INSTRUMENT PACKAGES

Adjustable support for instrument package
Oct page 77 GSC-13381

INSULATION

High-temperature insulating gap filler
Jul page 52 MSC-21644

INTEGRATED CIRCUITS

Multiple-bit errors caused by single ions
Jul page 38 NPO-18075

INTERFACES

Designing accelerated tests of electromigration
Aug page 54 NPO-18012

JACOBI INTEGRAL

Five-segment interconnection for electromigration tests
Aug page 18 NPO-18105

JET PUMPS

Addressable-matrix integrated-circuit test structure
Nov page 32 NPO-18162

JIGS

Jig for compression-relaxation tests of plastics
Jun page 26 LAR-13950

INTERFEROMETERS

Point-diffraction interferometer for flow experiments
Mar page 34 ARC-12489

INTERFEROMETRY

Equal-path, phase-shifting, sample-point interferometer
Apr page 61 NPO-17913

INTERFACES

Broadband, achromatic Twyman-Green interferometer
Oct page 38 NPO-17675

INTERFEROMETRY

Two-wavelength interferometric keratometer
Feb page 39 NPO-17537

INTERFEROMETRY

Improving sparse-aperture interferometric radiometry
Mar page 26 NPO-17886

JOULE-THERMSON EFFECT

Detection of motion with a phase-conjugate mirror
Oct page 40 NPO-17784

JOULE-THERMSON EFFECT

Improved interferometric photorefractive optical processor
Oct page 39 NPO-17773

Single-exposure long-equivalent-wavelength interferometry
Nov page 52 NPO-17580

JUNCTION TRANSISTORS

Edge-geometry NbN/MgO/Nb tunnel junctions
Oct page 18 NPO-17812

JOURNAL BEARINGS

Bearing-cartridge damping seal
Aug page 77 MFS-29657

KALMAN FILTERS

The history of the Kalman filter
Jul page 87 ARC-11734

KEVLAR (TRADEMARK)

Bonding aramid rope to metal fitting
Jan page 47 MSC-21618

LABORATORIES

Controlling laboratory processes from a personal computer
Sep page 88 LEW-14907

Facility measures magnetic fields
Sep page 65 NPO-18187

LABYRINTH SEALS

Computing flow in a labyrinth seal
Jun page 98 MFS-29682

LAMINAR FLOW

Making large suction panels for laminar-flow control
Feb page 61 LAR-13844

LAMINATES

Triangular element for analyzing elasticity of laminates
Jul page 68 ARC-12534

LAND MOBILE SATELLITE SERVICE

Multistage estimation of frequency and phase
Jan page 27 NPO-17911

End-loaded, cavity-backed, cross-slot antennas
Sep page 30 NPO-18100

LANDING MODULES

Reusable manned lunar vehicle
Nov page 89 MFS-28454

LAPLACE TRANSFORMATION

Transfer functions via Laplace and Fourier-Borel transforms
Sep page 112 ARC-12295

LARGE SPACE STRUCTURES

Low-frequency suspension system for large space structures
Jun page 62 LAR-14149

Dynamic analyses including joints of truss structures
Dec page 62 LAR-14306

LASER APPLICATIONS

Video recording of images in laser remote sensing
Jul page 26 GSC-13398

COMPENSATING FOR MOVEMENT OF EYE IN LASER SURGERY

Compensating for movement of eye in laser surgery
Nov page 46 MSC-21509

LASER DOPPLER VELOCIMETERS

Laser velocimeter for outdoor or wind-tunnel measurements
May page 38 NPO-17569

1991 Annual Subject Index

Jul page 40	ARC-12592	Dual-diaphragm tank with leakage-indicating drain	Sep page 91	MSC-21703
Modification of catadioptric telescope for laser velocimetry				
Aug page 56	ARC-12610			
LASER INTERFEROMETRY				
Point-diffraction interferometer for flow experiments				
Mar page 34	ARC-12489			
Single-exposure long-equivalent-wavelength interferometry				
Nov page 52	NPO-17580			
LASER MATERIALS				
Long-life-time laser materials for effective diode pumping				
Feb page 42	LAR-13807			
LASER MODE LOCKING				
Self-injection locking of diode lasers				
Jun page 46	NPO-17665			
LASER MODES				
Automatic rejection of multimode laser pulses				
Dec page 24	NPO-17777			
LASER SPECTROMETERS				
Computer processing of tunable-diode-laser spectra				
May page 28	NPO-18019			
LASER SPECTROSCOPY				
Laser spectroscopic measurement of temperature and density				
May page 43	ARC-12719			
LASER WELDING				
Laser welding of contoured thin-wall housings				
Mar page 57	MFS-29653			
LASERS				
Semiconductor laser with multilayer dielectric reflector				
Feb page 18	NPO-17763			
Lateral-grating DFB laser				
Mar page 22	LAR-13977			
Low-loss coupler for microwave laser-diode modulation				
Apr page 22	LAR-13788			
Acousto-optical filter can rapidly tune solid-state lasers				
Jun page 52	NPO-17891			
Multiple integrated in-line diode lasers				
Nov page 34	LAR-14378			
Two-period gratings for surface-emitting lasers				
Dec page 26	NPO-18054			
LATCHES				
Thermally actuated unlatching mechanism				
May page 57	NPO-17601			
Push-to-lock, push-to-release mechanism				
Jul page 73	MSC-21520			
LAUNCHERS				
Superconducting magnetic projectile launcher				
Mar page 48	NPO-17746			
LEAD ACID BATTERIES				
Reinforced positive filler paste for lead/acid batteries				
Jan page 20	NPO-16991			
Lightweight, high-energy lead/acid battery				
Apr page 22	NPO-16962			
LEAKAGE				
Rotary coupling extends life of hose				
Mar page 49	GSC-13316			
Design and analysis of linear control systems				
Aug page 59	KSC-11376			
Polynomial transformations for discrete-time linear systems				
Sep page 110	ARC-12204			

Technology 2001 Conference Proceedings

Over 1000 pages of high-tech innovations developed by NASA, the departments of Defense and Energy, and other key government agencies. Two-volume set features 120 papers describing new inventions available to industry in:

- ✓ Biotechnology
- ✓ Computer Technology
- ✓ Electro-optics
- ✓ Life Sciences
- ✓ Materials Science
- ✓ Robotics and AI
- ✓ Communications
- ✓ Electronics
- ✓ Environmental Technology
- ✓ Manufacturing
- ✓ Medicine
- ✓ Test and Measurement

Only \$59.95 while supplies last.

Send me _____ copies of the T2001 proceedings at \$59.95 each plus \$4.00 for shipping. (NY residents add sales tax to total.) Total enclosed: \$ _____

Name _____

Company _____

Address _____

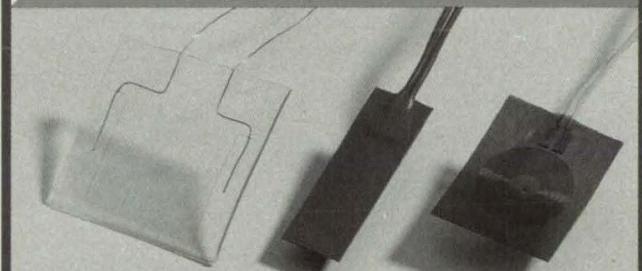
City/St/Zip _____

Mail with check or money order to: Technology Utilization Foundation, 41 East 42nd St., #921, New York, NY 10017.

For credit card orders call (212) 490-3999.

Thermal-Ribbon™ Resistance Thermometers

FORM



FIT

Aerospace instrumentation • Medical devices
Process control • Surface sensing

FUNCTION

Flexible resistance thermometers conform to surfaces for precise thermal response. They're small, rugged, lightweight, fast responding. And you can install them almost anywhere.

- Platinum to U.S. or DIN standards; nickel, copper, nickel-iron
- Kapton, silicone rubber insulation • -200 to 220°C range

7300 Commerce Ln.
Minneapolis, MN
55432-3177 USA

MINCO
PRODUCTS, INC.

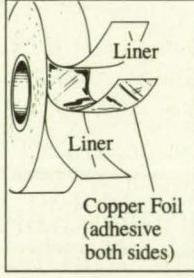
Ph: 612/571-3121
Fax: 612/571-0925
FAX: 612/571-0927

3M Announces Double-Coated Foil Shielding Tape

Copper foil base with electrically-conductive adhesive on both sides for reliable point-to-point conductivity.

Austin, Tex. — This new UL Recognized tape has a multitude of uses in electronic design, test, and QC laboratories where good adhesion and reliable conductivity are required. Applications include shielding PC boards, microwave antennas, and display boards; grounding, bonding and static charge draining.

Scotch™ Brand Electrical Tape #1182 features excellent shielding over a frequency range from 1 MHz to 1 GHz, measured in the Near Field using a modified Mil Std 285 test procedure.



In IC applications, #1182 tape also provides an excellent heat-conductive path to protect sensitive areas from excessive thermal exposure. The tape is rated at Class 155°C continuous operating temperature.

It is supplied on a liner that permits easy handling and die-cutting without seriously wrinkling the foil backing. A line of standard dispensers is available to increase productivity. The dispensers are available with liner take-up attachments and can deliver either random or definite lengths. Custom application equipment can be designed for automatic or semi automatic production.

For more information about all 3M foil tapes, contact a 3M Electrical Specialties Division representative or authorized distributor or call 1-800-233-3636.

Associative-memory array of optical logic gates
May page 30 NPO-17997

Orthogonal patterns in a binary neural network
May page 72 ARC-12454

LOOPS

Digital accumulators in phase- and frequency-tracking loops
Aug page 30 NPO-17909

Digital phase-locked loop with phase and frequency feedback
Nov page 36 NPO-17722

LOW NOISE

Low-noise charge-coupled device
Oct page 20 NPO-18031

LUBRICATION

Lubrication of nonconformal contacts
Feb page 57 LEW-14882

LUMINOUS INTENSITY

Circuit detects faint flashes against bright background
Sep page 19 MFS-28466

LUNAR SPACECRAFT

Reusable manned lunar vehicle
Nov page 89 MFS-28454

M

MACHINERY

Improved computation of dynamic stresses
Jan page 39 MFS-29745

MACHINING

Electrical-discharge machining with additional axis
Feb page 63 MFS-29630

MAGNESIUM ALLOYS

Plasma spraying reclaims compressor housings
Jan page 44 LEW-14899

MAGNETIC BEARINGS

Improved notch filter for synchronous-response control
Apr page 48 LAR-14173

MAGNETIC FIELDS

Facility measures magnetic fields
Sep page 65 NPO-18187

MAGNETIC STORAGE

Magnetic analog random-access memory
Nov page 30 NPO-17998

MAGNETIC TAPES

Matrix encoding for correction of errors
Oct page 108 NPO-17834

MAGNETOPTICS

Optical isolators with transverse magnet
Feb page 36 LAR-14092

MAGNETORESISTIVITY

Fast magnetoresistive random-access memory
Apr page 32 NPO-17954

MAINTENANCE

Programmable maintenance processor for XAIDS
Oct page 31 ARC-12164

Repairing a shaft prone to fatigue
Oct page 94 MFS-28518

MANAGEMENT

Tracing and control of engineering requirements
Dec page 56 NPO-18215

MAN-COMPUTER INTERFACE

YAMM—yet another menu manager
Feb page 47 NPO-17769

MANDRELS

Multipiece mandrel for spray-forming complex parts
Mar page 57 MFS-29680

MANIFOLDS (MATHEMATICS)

Self-motion manifolds of redundant manipulators
Sep page 101 NPO-17965

MANIPULATORS

Conjugate gradient algorithms for manipulator simulation
Apr page 84 NPO-17929

LUMINOUS INTENSITY

Efficient computation of inertia matrix of a manipulator
May page 70 NPO-17545

SEGMENTED ARM

Segmented arm for positioning and assembly
May page 58 MSC-21512

ANALYSIS OF CONTROL

Analysis of control of cooperating robot arms
Jul page 86 NPO-17789

EXPERIENCES WITH THE JPL

Experiences with the JPL telerobot testbed
Aug page 30 NPO-17928

Spatial-operator algebra for robotic manipulators

Aug page 88 NPO-17770

ANTHROPOMORPHIC ROBOT

Anthropomorphic robot hand and teaching glove
Sep page 99 GSC-13244

Parallel-processing algorithms for dynamics of manipulators

Sep page 111 NPO-17718

Self-motion manifolds of redundant manipulators

Sep page 101 NPO-17965

REDUNDANT ROBOT

Redundant robot can avoid obstacles
Oct page 86 NPO-17852

Sensing temperatures via prostheses and manipulators

Oct page 35 MSC-21676

SYSTEM FOR RESEARCH ON

System for research on multiple-arm robots
Oct page 30 NPO-17971

VISELIKE ROBOTIC GRIPPER

Oct page 86 GSC-13232

DIRECT-LINK PREHENSOR

Dec page 78 ARC-11666

MAN-MACHINE SYSTEMS

h-Parameter analysis of teleoperators
Jun page 97 NPO-17527

MANNED ORBITAL TELESCOPES

Aiming schedule for orbiting astrometric telescope
Aug page 57 ARC-12103

MANNED SPACECRAFT

Carrying humans to and from Mars
Aug page 78 MFS-28453

REUSABLE MANNED LUNAR

Vehicle
Nov page 89 MFS-28454

MAPPING

Improved remapping processor for digital imagery
Jul page 26 MSC-21481

Program computes universal transverse Mercator projection
Jul page 62 NPO-18086

MAPS

Helicity-density and normalized-helicity maps of flows
Aug page 62 ARC-12464

MARKING

Bar-code-scribing tool
Mar page 58 MFS-28441

MARKOV PROCESSES

Hidden-Markov-model analysis of telemanipulator data
Oct page 87 NPO-18000

MARS LANDING

Carrying humans to and from Mars
Aug page 78 MFS-28453

MASERS

Performance of superconducting-cavity maser
Jun page 30 NPO-18175

MASS DRIVERS (PAYLOAD DELIVERY)

Electromagnetic gun with commutated coils
Apr page 26 NPO-17839

MASS SPECTROSCOPY

GC/MS gas separator operates at lower temperatures
Jun page 50 NPO-17930

MASS TRANSFER

Contamination analysis program
Oct page 66 NPO-17982

MATHEMATICAL MODELS

Global reference atmosphere model—1988
Jan page 35 MFS-28397

PROGRAMS FOR MODELING

Fault-tolerant computing systems
Jan page 37 LAR-14165

MICROWAVE BRIGHTNESS OF LAND SURFACES

From outer space
May page 34 NPO-17739

GENERATION OF SURFACE GRIDS

From data points
Dec page 86 ARC-12481

SOFTWARE FOR DEPICTION OF THREE-DIMENSIONAL OBJECTS

Dec page 55 MSC-21540

SYNCHRONIZING ROTATION OF A HEAVY LOAD

Jun page 103 GSC-13325

MATRICES (MATHEMATICS)

Optical computation of matrices from vectors
Feb page 70 NPO-17512

POLYNOMIAL TRANSFORMATIONS FOR DISCRETE-TIME LINEAR SYSTEMS

Sep page 110 ARC-12204

MATRIX MATERIALS

LaRC-RP41: a tough, high-performance composite matrix
Sep page 82 LAR-14338

PHENYLATED POLYIMIDES WITH GREATER SOLUBILITY

Oct page 46 LAR-14170

ROTATIONALLY ACTUATED PROSTHETIC HAND

Feb page 69 MFS-28465

MAXIMUM LIKELIHOOD ESTIMATES

Computing confidence limits
Mar page 46 MFS-29476

MEASURING INSTRUMENTS

Measuring adhesion and friction forces
Jan page 39 LEW-14903

Gauge measures thicknesses of blankets

Mar page 47 MSC-21693

Optoelectronic shaft-angle encoder tolerates misalignments

Apr page 47 GSC-13175

Weld-bead profilometer rejects optical noise

Apr page 40 MFS-26115

Cross-quint-bridge resistor

Jun page 28 NPO-18106

Measuring flux density of monatomic oxygen

Jun page 50 MFS-28446

Integral plug-type heat-flux gauge

Aug page 72 LEW-14967

Computer-driven keratometer

Sep page 118 NPO-17079

Improved force-and-torque sensor assembly

Sep page 95 NPO-17370

Broadband, achromatic Twyman-Green interferometer

Oct page 38 NPO-17675

Ionizable-substance detector

Dec page 38 MFS-28515

MECHANICAL DEVICES

Push-to-lock, push-to-release mechanism
Jul page 73 MSC-21520

Reusable mechanical pin puller

Sep page 97 GSC-13355

Bidirectional drive-and-brake mechanism

Oct page 88 MSC-21540

Rotary-to-axial motion converter for valve

Oct page 76 MSC-21697/8

MECHANICAL PROPERTIES

Layered plating specimens for mechanical tests
Nov page 94 MFS-29718

MEDICAL EQUIPMENT

Prosthetic hand lifts heavy loads
Feb page 69 MFS-28465

Rotationally actuated prosthetic hand

Feb page 69 MFS-28426

MEISSNER EFFECT

Meissner-effect stepping motor
Feb page 59 MFS-28409

MEMBRANES

Membrane bioreactor with pressure cycle
Jan page 55 NPO-17974

Casting of multilayer ceramic tapes
Jun page 110 NPO-17166

MEMORY (COMPUTERS)

Conditional probability and the sparse distributed memory
Apr page 100 NPO-17902

Fast magnetoresistive random-access memory
Apr page 32 NPO-17954

Ferroelectric memory capacitors for neural networks
Apr page 26 NPO-17973

Stacked-gate FET's for analog memory elements
Jul page 16 NPO-17627

Trinary associative memory would recognize machine parts
Sep page 52 NPO-17850

Magnet/Hall-effect random-access memory
Nov page 28 NPO-17999

Magnetic analog random-access memory
Nov page 30 NPO-17998

MERCATOR PROJECTION
Program computes universal transverse Mercator projection
Jul page 62 NPO-18086

MERCURY ISOTOPES
Trapped-mercury-ion frequency standard
Jun page 55 NPO-17456

METAL BONDING
Spot-welding gun is easy to use
Jun page 119 MFS-29693

METAL PLATES
Uniform-dead-weight brazing
Nov page 91 MSC-21627

MESH
Making high-pass filters for submillimeter waves
Aug page 83 NPO-17992

METAL JOINTS
Monitoring weld penetration via gas pressure
May page 64 MFS-29683

METALLOGRAPHY
Improved metallurgy of thermal-barrier coatings
Apr page 56 LEW-15006

METAL SHEETS
Computer-aided design of sheet-material parts
Aug page 83 MFS-29759

MICROCHANNELS
Micro channel/Multibus-II interface circuit
Jul page 24 MSC-21506

MICROMETERS
Measuring electrical resistivity of compacted powder
Nov page 58 NPO-18056

MICROSCOPES
Microscope would image x and y rays
Sep page 71 MFS-28484

MICROSCOPY
Vacuum chuck holds filter pad for counting particles
Apr page 52 MFS-28420

Imaging microscope for "water-window" x rays
Jul page 40 MFS-28485

Human expertise helps computer classify images
Oct page 110 MSC-21737

MICROWAVE ANTENNAS
Analyzing large reflector antenna structures
Apr page 77 NPO-17783

Magawatt square microwave feed horn
Jun page 22 NPO-18025

Reducing cross-polarized radiation from a microstrip antenna
Aug page 20 NPO-18147

End-loaded, cavity-backed, cross-slot antennas
Sep page 30 NPO-18100

MICROWAVE IMAGERY
Spaceborne microwave imagers
Dec page 42 NPO-17094

MICROWAVE LANDING SYSTEMS
Back azimuth guidance in departures and missed approaches
Jul page 39 ARC-12611

MICROWAVE OSCILLATORS
Low-loss coupler for microwave laser-diode modulation
Apr page 22 LAR-13788

Microwave oscillator would have reduced phase noise
Jun page 20 NPO-17945

Sapphire ring resonator for microwave oscillator
Sep page 20 NPO-18082

MICROWAVE RADIOMETERS
Improving sparse-aperture interferometric radiometry
Mar page 26 NPO-17886

Accounting for nonlinearity in a microwave radiometer
May page 40 NPO-17451

MICROWAVES
Microwave levitation of small objects
Sep page 109 NPO-18006

MILLIMETER WAVES
Quasi-optical millimeter-wavelength resonator
Jun page 16 NPO-17919

MINERAL OILS
Hot oil removes wax
Feb page 60 MFS-29713

MIRRORS
Lightweight substrates for mirrors
Jan page 32 NPO-17854

Equal-path, phase-shifting, sample-point interferometer
Apr page 61 NPO-17913

Fabrication of lightweight mirrors via CVD
Jun page 122 LAR-14299

Lightweight composite core for curved composite mirrors
Jun page 116 NPO-17858

Closed-loop chopping-mirror controller
Sep page 50 ARC-11177

Development of composite panels for telescope mirrors
Oct page 100 NPO-17895

Lighted, folding inspection mirror
Oct page 92 MFS-28457

Conical mirrors for quasi-retroreflection
Nov page 54 NPO-18005

MISSILES

Aerodynamics of missiles: present and future
Oct page 83 ARC-12188

MISSION PLANNING
Automated scheduling via artificial intelligence
Aug page 86 NPO-18209

Graphical planning of spacecraft missions
Aug page 60 GSC-13318

MIXING

Three-dimensional structure of a mixing layer
Nov page 79 ARC-12506

MIXING LENGTH FLOW THEORY
Growth of instabilities in two types of mixing layers
Aug page 75 ARC-12567

MODULATION
Interleaving would enhance trellis-coded modulation
Jan page 52 NPO-17899

MODULATORS
Resolving phase ambiguities in QPSK
Jul page 30 NPO-17853

Wideband phase-locked angle modulator
Dec page 36 NPO-18047

MODULES
Docking system would accommodate misalignments
Aug page 68 MSC-21596

MOIRE EFFECTS
Three-dimensional moire pattern
Apr page 97 MSC-21416

MOISTURE RESISTANCE
Effects of moisture on zinc orthotitanate paint
Mar page 41 NPO-17742

MOLDS
Flexible interior-impression-molding tray
May page 63 MFS-29679

MOLECULAR BEAM EPITAXY
Molecular beam epitaxy of IrSi_3
Feb page 60 NPO-17953

MILLIMETER WAVES
Quasi-optical millimeter-wavelength resonator
Jun page 16 NPO-17919

MINERAL OILS
Formation of ohmic contacts on epitaxial GaAs
Mar page 58 NPO-17795

MIRRORS
Growing cobalt silicide columns in silicon
Jun page 121 NPO-17835

MONOCHEMATORS
Compact x-ray and extreme-ultraviolet monochromator
Jun page 44 MFS-28499

Four-mirror x-ray and extreme-ultraviolet monochromator
Jun page 44 MFS-28498

Scanning x-ray or extreme-ultraviolet monochromator
Aug page 52 MFS-28492

Ultra-high-spectral-resolution x-ray/EUV monochromator
Sep page 70 MFS-28500

MONTE CARLO METHOD
Conditional probability and the sparse distributed memory
Apr page 100 NPO-17902

MOTORS
Meissner-effect stepping motor
Feb page 59 MFS-28409

Pulse-width-modulating driver for brushless dc motor
Sep page 18 NPO-17142

MOUNTING
Self-aligning sensor-mounting fixture
Jun page 107 MFS-29663

MULLITES

Phase transformations in mullite-precursor xerogels
Feb page 44 LEW-14898

Making mullite fibers by airgap wet spinning
May page 60 MFS-28431

MUSCLES
Intramuscular contact lead filled with conductive solution
May page 74 NPO-17186

N

NAVIER-STOKES EQUATION
Faster algorithm for computation of incompressible flow
Feb page 52 ARC-12370

MODULATORS
Resolving phase ambiguities in QPSK
Jul page 30 NPO-17853

Calculation of pneumatic attenuation in pressure sensors
Mar page 47 ARC-12210

Calculating viscous/inviscid interactions
Apr page 85 ARC-12115

Streamwise algorithm for simulation of flow
Jul page 70 ARC-12718

Computed hypersonic flow about a sharp cone
Oct page 85 ARC-12675

Navier-Stokes simulation of wind-tunnel flow
Oct page 85 ARC-12193

Transonic flows about a fighter airplane
Oct page 79 ARC-12304

A general-coordinate formulation for boundary-layer flow
Dec page 59 ARC-12465

Computations of impulsively started viscous flow
Dec page 75 ARC-12382

Computed hypersonic viscous flows over delta wings
Dec page 70 ARC-12179

Direct finite-difference simulations of turbulent flow
Dec page 76 ARC-12463

Methods of simulation of incompressible flow
Dec page 74 ARC-12199

Navier-Stokes computations on zonal grids
Dec page 71 ARC-12447

Numerical simulation of flow through an artificial heart
Dec page 66 ARC-12478

3M Lowers Cost of High Temperature Electrical Tapes

New proprietary film matched with acrylic and silicone adhesives for UL Class 155°C/180°C

AUSTIN, Tex. — Two newly developed high temperature electrical insulating tapes are lower priced than current tape constructions now on the market. The secret is in matching new tough proprietary film with appropriate high temperature adhesives.

Scotch™ Electrical Tape 72 is thin, high temperature resistant, light tan, and semi-opaque. It is combined with an acrylic pressure-sensitive adhesive, and is UL Recognized for continuous use at temperatures not exceeding 155°C, for class F operating components.

Scotch™ Electrical Tape 73 is thin, high temperature resistant, light brown, and semi-transparent. It is combined with a silicone pressure-sensitive adhesive, and is UL Recognized for continuous use at temperatures not exceeding 180°C, for class H operating components.



Flexibility, conformability and flagging resistance are also key features. UL Component Recognition.

Typical high temperature electrical insulating applications are in motors, coils, transformers, TV yoke/deflection magnets, wrap and fill capacitors, and similar electrical and electronic products.

Both tapes are flame retardant, flagging resistant and meet NASA outgassing requirements.

Permanently printable using conventional tape printing equipment. Standard widths from 1/16" to 4". Custom slitting available.

For more information, contact a 3M Electrical Specialties Division representative or authorized distributor or call 1-800-233-3636.



3M Electrical Specialties Division

PO Box 2963

Austin, TX 78769-2963

Circle Reader Action No. 409 95

NAVIGATION AIDS

The history of the Kalman filter
Jul page 87 ARC-11734

Matching terrain-height maps for a robotic vehicle
Oct page 108 NPO-17856

NEODYMIUM LASERS

Long-lifetime laser materials for effective diode pumping
Feb page 42 LAR-13807

NEURAL NETS

Neural networks of VLSI components
Feb page 24 NPO-17833

Simplified learning scheme for analog neural network
Feb page 26 NPO-17664

Conditional probability and the sparse distributed memory
Apr page 100 NPO-17902

Ferroelectric memory capacitors for neural networks
Apr page 26 NPO-17973

Orthogonal patterns in a binary neural network
May page 72 ARC-12454

Stacked-gate FET's for analog memory elements
Jul page 16 NPO-17627

Terminal attractors in neural networks
Jul page 89 NPO-17832

Alternative Al_xGa_{1-x}As/GaAs transistors for neural networks
Sep page 26 NPO-18177

High gain Al_xGa_{1-x}As/GaAs transistors for neural networks
Sep page 24 NPO-18101

Trinary associative memory would recognize machine parts
Sep page 52 NPO-17850

Neural-network control of prosthetic and robotic hands
Oct page 28 MSC-21642

Generation of surface grids from data points
Dec page 86 ARC-12481

NICKEL ALLOYS
Controlled temperature gradient improves freezing alloy
Sep page 83 MFS-28314

Alloy has high fatigue strength in hydrogen
Nov page 62 MFS-28464

NICKEL HYDROGEN BATTERIES
Lightweight fibrous Ni electrodes for Ni/H₂ batteries
Jul page 56 LEW-14955

NITROUS OXIDES
Nitrous oxide in the antarctic stratosphere
Apr page 63 ARC-12223

NOISE (SOUND)
Research in helicopter noise
Aug page 74 ARC-12171

NOISE REDUCTION
Microwave oscillator would have reduced phase noise
Jun page 20 NPO-17945

NONAQUEOUS ELECTROLYTES

Lithium cells accept hundreds of recharges
Jun page 28 NPO-17676

NONDESTRUCTIVE TESTS

Testing conductive films for continuity
Feb page 41 NPO-17938

Circuit for current-vs.-voltage tests of semiconductors
Apr page 24 MFS-29623

Detecting filler spaces under tiles
May page 61 KSC-11411

NONLINEAR FEEDBACK

Nonlinear dynamic compensation for feedback control
Nov page 47 NPO-17993

NONLINEAR SYSTEMS

Entropy-based approach to nonlinear stability
Jul page 76 ARC-12435

NONLINEARITY

Accounting for nonlinearity in a microwave radiometer
May page 40 NPO-17451

NOZZLE DESIGN

Self-adjusting choke for nozzle
Aug page 64 NPO-17625

NOZZLE GEOMETRY

Two-phase Hero turbine with curved nozzles
Nov page 87 NPO-18059

NUCLEATION

Initiating growth of crystals away from container walls
Sep page 106 MFS-28473

NUMERICAL INTEGRATION

Overview of methods for computation of shocks
Jul page 74 ARC-12667

Speeding convergence in simulations of hypersonic flow
Oct page 82 ARC-12601

NUTRIENTS

Closed-cycle nutrient supply for hydroponics
Jul page 90 MSC-21655

NUTS (FASTENERS)

Staking pliers
Sep page 104 MSC-21725

O

O RING SEALS

O-ring-testing fixture
Feb page 54 MFS-28414

Placement of O-rings in solid rocket booster
Aug page 76 NPO-18008

Sealing out-of-round tubes with O-rings
Sep page 104 NPO-17791

OCEAN SURFACE

Azimuthal anisotropy in radar backscatter from the ocean
Sep page 79 NPO-17422

Radar backscatter from the ocean at low wind speeds
Sep page 79 NPO-18036

Removing ambiguities in remotely sensed winds
Nov page 99 NPO-18079

OCULOMETERS

Instrument measures ocular counterrolling
Dec page 91 MSC-21711

OIL SLICKS

Removing spilled oil with liquid nitrogen
Mar page 38 LAR-14227

OPERATING SYSTEMS (COMPUTERS)

DOS batch files as control programs
Nov page 101 MSC-21570

OPERATOR PERFORMANCE

Human error in complex systems
Apr page 101 ARC-12424

OPERATORS (PERSONNEL)

Valve- and switch-monitoring computer program
Nov page 98 MSC-21720

OPHTHALMOLOGY

Portable video/digital retinal funduscope
Sep page 115 MSC-21675

OPTICAL COMMUNICATION

Optical backplane interconnection
Feb page 20 LAR-14052

Optical receiver based on luminescent light trapping
Apr page 59 NPO-17916

Transmitting reference radio signal on two optical carriers
Jun page 32 NPO-18007

OPTICAL COMPUTERS

Optical computation of matrices from vectors
Feb page 70 NPO-17512

OPTICAL CORRECTION PROCEDURE

Optical modeling of segmented mirror telescopes
Mar page 36 NPO-17961

Ruling blazed, aberration-corrected diffraction gratings
Oct page 97 GSC-13240

OPTICAL DATA PROCESSING

Detection of motion with a phase-conjugate mirror
Oct page 40 NPO-17784

Improved interferometric photorefractive optical processor
Oct page 39 NPO-17773

OPTICAL EQUIPMENT

Optical isolators with transverse magnet
Feb page 36 LAR-14092

Lightweight composite core for curved composite mirrors
Jun page 116 NPO-17858

Computing performance of an optical system
Jul page 60 GSC-13128

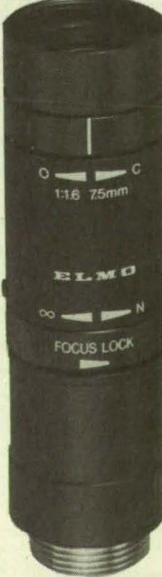
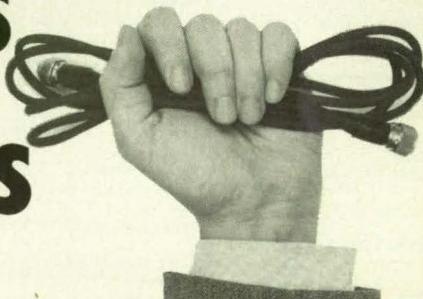
OPTICAL FILTERS

Acousto-optical filter can rapidly tune solid-state lasers
Jun page 52 NPO-17891

OPTICAL HETRODYNING

Self-heterodyne-laser-spectrum analyzer
Sep page 66 GSC-13397

NEW ELMO MN401 SVHS COLOR CAMERA GOES TO VERY GREAT LENGTHS FOR YOU



100 feet to be exact! That's the cable length available with ELMO's new MN401, the microdesign, super-high resolution (460 H lines) remote head 1/2" CCD color video camera system. Weighs less than one ounce. Can be installed virtually anywhere. Choice of cable lengths and six lenses, including 3, 4, 7.5, 15, 24mm and a 7mm pinhole.

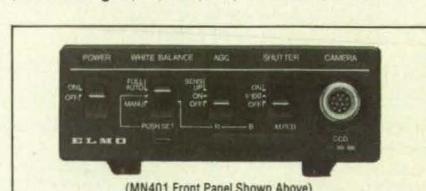
The MN401 also features YC output for Super VHS, composite video output, 300,000 pixels, nine electronic shutter speeds from 1/60th to 1/10,000th of a second to freeze action, view very intense illumination, and an ultra-miniature 17.5mm x 54mm rotating remote camera head. Our advanced new sensor corrects white balance at the speed of light for optimum color rendition.

The advanced new ELMO MN401 is smartly priced about the same as its famous predecessor, the ELMO EM-102.

So, if easy-to-install, extra-long cable and crystal clear images are important factors in your miniature CCD camera applications, the ELMO MN401 goes the extra distance for you.

Get the complete technical specs and find out just how far that is.

For fast action, call Vince Giovinco or any of our CCD/ITV experts at 1-800-654-7628.



(MN401 Front Panel Shown Above)

MN-401 REAR PANEL

- Outputs for both SVHS and composite video
- Internal/external sync terminal
- Adjustable electronic shutter—dial speeds up to 1/10,000th sec.
- Subcarrier phase adjustment

ELMO

70 New Hyde Park Road, New Hyde Park, NY 11040
44 West Drive, Brampton, Ontario, Canada L6T 3T6

1991 Annual Subject Index

OPTICAL MEASURING INSTRUMENTS

Equal-path, phase-shifting, sample-point interferometer
Apr page 61 NPO-17913

Low-speed optical speedometer
Jun page 54 NPO-17702

Laser velocimeter for outdoor or wind-tunnel measurements
Jul page 40 ARC-12592

OPTICAL MEMORY (DATA STORAGE)

Associative-memory array of optical logic gates
May page 30 NPO-17997

OPTICAL PROPERTIES

Organometallic salts generate optical second harmonics
Jun page 54 NPO-17730

OPTICAL PUMPING

Computing temperatures in optically pumped laser rods
Jul page 63 LAR-14209

OPTIMIZATION

Numerical-optimization program
Dec page 57 LAR-14500

OPTOELECTRONIC DEVICES

Optoelectronic ranging sensor for robotic vehicle
Mar page 26 NPO-17959

Optoelectronic shaft-angle encoder tolerates misalignments
Apr page 47 GSC-13175

ORBITAL MANEUVERS

Plotting orbital trajectories for maneuvers
Oct page 68 ARC-12365

ORIFICES

Self-adjusting choke for nozzle
Aug page 64 NPO-17625

OSCILLATIONS

Rotary coupling extends life of hose
Mar page 49 GSC-13316

OSCILLATORS

Performance of superconducting-cavity maser
Jun page 30 NPO-18175

OXIDATION

Platinum/tin oxide/silica gel catalyst oxidizes CO
Apr page 66 LAR-14155

OXYGEN

Adsorbent removes traces of oxygen
Apr page 67 NPO-17947

OXYGEN ATOMS

Reactions of atomic oxygen [$O(^3P)$] with polybutadienes
Apr page 72 ARC-11851

Measuring flux density of monatomic oxygen
Jun page 50 MFS-28446

Monatomic-oxygen reactors for materials testing and surface chemistry
Jun page 48 MSC-21505

OXYGEN PRODUCTION

Stacking oxygen-separation cells
Jun page 118 NPO-17223

OXYHEMOGLOBIN

Computation of facilitated transport of O_2 in hemoglobin
Jun page 128 ARC-12417

P

PADE APPROXIMATION

Programs for modeling fault-tolerant computing systems
Jan page 37 LAR-14165

PAINTS

Effects of moisture on zinc orthotitanate paint
Mar page 41 NPO-17742

PANEL METHOD (FLUID DYNAMICS)

Improved panel-method/potential-flow code
Oct page 66 ARC-12642

PANELS

Device measures angle of deployment
Apr page 36 GSC-13351

PARABOLIC ANTENNAS

Fast approximate analysis of modified antenna structure
Mar page 64 NPO-17901

PARABOLOID MIRRORS

Optical modeling of segmented mirror telescopes
Mar page 36 NPO-17961

PARACHUTES

Selectable-towline spin-chute system
Nov page 84 LAR-14322

PARALLEL PROCESSING (COMPUTERS)

Algorithmically specialized parallel architecture for robotics
Feb page 22 NPO-17632

NEURAL NETWORKS

Neural networks of VLSI components
Feb page 24 NPO-17833

PHASE LOCKED SYSTEMS

Digital phase-locked loop with phase and frequency feedback
Nov page 36 NPO-17722

PHASE MODULATION

Simultaneous detection and estimation amid strong dynamical effects
Jan page 28 NPO-17820

WIDEBAND PHASE-LOCKED ANGLE MODULATOR

Wideband phase-locked angle modulator
Dec page 36 NPO-18047

PHASE SHIFT KEYING

Interleaving would enhance trellis-coded modulation
Nov page 69 NPO-18037

FAST PARALLEL COMPUTATION OF MANIPULATOR INVERSE DYNAMICS

Fast parallel computation of manipulator inverse dynamics
Dec page 89 NPO-18080

R-PARAMETERIZATION

R-parameterization of linear feedback systems
Oct page 106 ARC-12369

PARTICLE FLUX DENSITY

Measuring flux density of monatomic oxygen
Jun page 50 MFS-28446

PARTICLE IN CELL TECHNIQUE

Particle-in-cell simulation of explosive flow
Oct page 84 ARC-12543

PARTICLES

Vacuum chuck holds filter pad for counting particles
Apr page 52 MFS-28420

PARTICULATES

Mathematical model for deposition of soot
Aug page 49 MFS-28506

Collectors of airborne and spaceborne particles
Sep page 74 NPO-18183

PASSIVITY

Passivation of high-temperature superconductors
Apr page 69 NPO-17949

PAYOUTLOADS

Calculating dynamics of helicopters and slung loads
Aug page 71 ARC-12755

PCM TELEMETRY

System decommutes and displays telemetry data
Sep page 89 GSC-13324

PENETRATION

Monitoring weld penetration via gas pressure
May page 64 MFS-29683

Penetrant-indication-measuring compass
Jun page 110 MFS-29643

PERMANENT MAGNETS

Mechanically oriented, low-Curie-temperature materials
Apr page 71 MFS-26110

PERSONAL COMPUTERS

Controlling laboratory processes from a personal computer
Sep page 88 LEW-14907

HYPERCLIPS

HyperCLIPS
Oct page 69 NPO-18087

System acquires and displays signal-propagation data
Sep page 64 NPO-18190

PHASE COHERENCE

Solar-cell cover glass would reduce reflectance loss
Jul page 22 LEW-14942

PHASE LOCKED SYSTEMS

Displaying computer simulations of physical phenomena
Feb page 32 ARC-12502

PHASE MODULATION

Simultaneous detection and estimation amid strong dynamical effects
Jan page 28 NPO-17820

WIDEBAND PHASE-LOCKED ANGLE MODULATOR

Wideband phase-locked angle modulator
Dec page 36 NPO-18047

PHASE SHIFT KEYING

Interleaving would enhance trellis-coded modulation
Jan page 52 NPO-17899

Multiple-symbol differential detection of MPSK
Mar page 30 NPO-17896

Multiple-symbol detection of multiple-trellis-coded MDPSK
Jun page 38 NPO-18043

Analysis of lock detection in Costas loops
Jul page 38 NPO-18102

Resolving phase ambiguities in OQPSK
Jul page 30 NPO-17853

Phase transformations in multilevel-precursor xerogels
Feb page 44 LEW-14898

Sealing out-of-round tubes with O-rings
Sep page 104 NPO-17791

Vacuum chuck holds filter pad for counting particles
Apr page 52 MFS-28420

Si_xGe/Si infrared photodiodes

Oct page 26 NPO-17950

PHOTOELECTRIC EMISSION

Heterojunction-internal-photoemission infrared detectors
Jan page 22 NPO-17879

PHOTOLYSIS

Monatomic-oxygen reactors for materials testing and surface chemistry
Jun page 48 MSC-21505

PHOTOMASKS

Rapid dry etching of photoresists without toxic gases
Jun page 104 ARC-11873

PHOTOMETERS

Characterization of electrical response of photodetector
Dec page 24 GSC-13349

Improved metallography of thermal-barrier coatings
Apr page 79 LAR-14015

PHOTOTRANSISTORS

Phototransistors for long-wavelength infrared
May page 26 NPO-18029

PHOTOVOLTAIC CELLS

Making ultrathin solar cells
Jan page 46 NPO-17798

PHOTOVOLTAIC CONVERSION

Solar-cell cover glass would reduce reflectance loss
Jul page 22 LEW-14942

PHYSICAL SCIENCES

Displaying computer simulations of physical phenomena
Feb page 32 ARC-12502

PHYSIOLOGY

Physiology of prolonged bed rest
Mar page 68 ARC-12241

Reducing thermal conduction in acoustic levitators
Jun page 120 NPO-17620

PINS

Lightweight memory-metal pin puller
Jul page 69 NPO-18131

Reusable mechanical pin puller
Sep page 97 GSC-13355

PIPE FLOW

Accounting for compressibility in viscous flow in pipes
Aug page 66 ARC-12249

PIPELINING (COMPUTERS)

Video pipeline tree for scan conversion of triangles
Aug page 27 ARC-11661

PIPES (TUBES)

Sealing out-of-round tubes with O-rings
Sep page 104 NPO-17791

PARTICLES

Ultrasonic device would open pipe bombs
Sep page 108 NPO-17951

PHOTODIODES

GaAsP photodiodes as x-ray detectors
Sep page 22 NPO-17849

Trailing shield for welding on pipes

Dec page 82 MFS-29743

PITOT TUBES

Adjustable pitot probe
Aug page 70 LAR-14232

PIVOTS

Contact probe with pivoting tip
Nov page 77 MFS-28536

PLANETARY ATMOSPHERES

Transformations for atmospheric-radiation calculations
Jul page 42 NPO-18026

PLANETS

Displaying images of planets
Jun page 57 NPO-17977

PLANFORMS

Crescent wing planforms reduce lift-dependent drag
Apr page 58 NPO-17904

PLANT ROOTS

Capillary-effect root-environment system
Dec page 92 KSC-11350

PLASMA ARC WELDING

Fast, nonspattering inert-gas welding
Feb page 61 MFS-29648

PLASMA SPRAYING

Plasma spraying reclaims compressor housings
Jan page 44 LEW-14899

PHYSICAL SCIENCES

Effects of heat sinks on VPPA welds
Oct page 99 MFS-27240

PLATING

Trailing shield for welding on pipes
Dec page 82 MFS-29743

PLASMA SPRAYING

Plasma spraying reclaims compressor housings
Jan page 44 LEW-14899

PLASMA SPRAYING

Heavy-workpiece handler for vacuum plasma spraying
Oct page 99 MFS-28522

PLASMAS (PHYSICS)

Effects of multiple ion species on plasma instabilities
Jul page 50 NPO-17771

PLASTIC FLOW

Particle-in-cell simulation of explosive flow
Oct page 84 ARC-12543

PLASTICS

Jig for compression-relaxation tests of plastics
May page 53 MSC-21674

PLATES (STRUCTURAL MEMBERS)

Fully-stressed-design algorithm for plate/shell structures
Nov page 75 ARC-12687

PLATING

Layered plating specimens for mechanical tests
Nov page 94 MFS-29718

PLATINUM BLACK

Optimum platinum loading in Pt/Sn_xCO-oxidizing catalysts
Jun page 56 LAR-14183

POLYMER MATRIX COMPOSITES

Impact damage in carbon/epoxy and carbon/PEEK composites
Apr page 72 MFS-27245

VACUUM POWDER INJECTOR

Vacuum powder injector
Oct page 93 LAR-14179

POISSON EQUATION

Generating three-dimensional grids about anything
Jun page 58 ARC-12620

POLARIMETRY

Status of imaging radar polarimetry
Jan page 30 NPO-17890

PROGRAM PROCESSES SAR DATA

Program Processes SAR data
Dec page 52 NPO-18048

POLARIZED LIGHT

Airborne laser polarization sensor
Feb page 34 GSC-13314

POLARIZED RADIATION

Polarization filtering of SAR data
Apr page 58 NPO-17904

POLLUTION CONTROL

Research animal holding facility prevents space lab contamination
Aug page 89 ARC-12599

POLYBUTADIENE

Reactions of atomic oxygen [$O(^3P)$] with polybutadienes
Apr page 72 ARC-11851

POLYETHYLENES

Superfiber for strong, light fabrics
Sep page 80 MSC-21659

POLYIMIDE RESINS

Polyamide-imides made from BTDA
May page 48 LAR-13942

POLYIMIDES

SiO_x protective coat for polyimide sheet
Apr page 73 LEW-14912

POLYIMIDE FIBERS

Making solid aromatic polyimide fibers
May page 44 LAR-14162

NEW SYNTHESIS OF HIGH-PERFORMANCE BISMALEIMIDES

New synthesis of high-performance bismaleimides
Jul page 54 LAR-13958

LA/RC-RP41: A TOUGH, HIGH-PERFORMANCE COMPOSITE MATRIX

LaRC-RP41: a tough, high-performance composite matrix
Sep page 82 LAR-14338

CRYSTALLINE IMIDE/ARYLENE ETHER COPOLYMERS

Crystalline imide/arylene ether copolymers
Oct page 47 LAR-14264

PHENYLATED POLYIMIDES WITH GREATER SOLUBILITY

Phenylated polyimides with greater solubility
Oct page 46 LAR-14170

IMIDE/ARYLENE ETHER COPOLYMERS

Imide/arylene ether copolymers
Dec page 44 LAR-14159

POLYMER MATRIX COMPOSITES

Impact damage in carbon/epoxy and carbon/PEEK composites
Apr page 72 MFS-27245

VACUUM POWDER INJECTOR

Vacuum powder injector
Oct page 93 LAR-14179

POLYMERIC FILMS

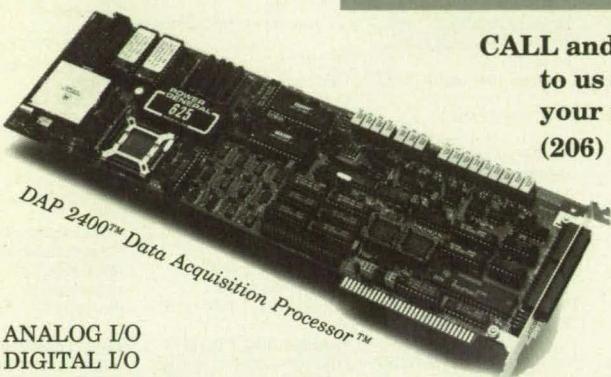
Push tester for laminated films
Sep page 92 NPO-18063

16 MHz CPU
DRAM to 512K

20 MHz DSP
SRAM to 96K

DAPL™ Operating System
100+ standard commands
Custom commands in C

The Intelligent Solution For Data Acquisition



ANALOG I/O
DIGITAL I/O

Inputs to 235K samples per second
Outputs to 250K samples per second

Or call for
FREE demo diskette.

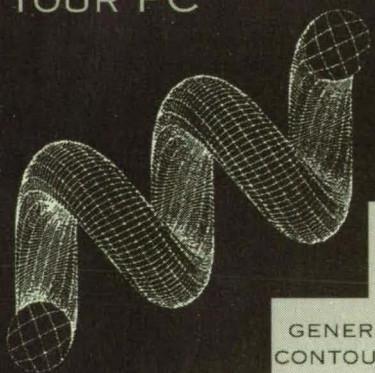
**CALL and talk
to us about
your project.
(206) 453-2345**

**MICROSTAR
LABORATORIES™**

2265 116th Avenue NE
Bellevue, WA 98004
FAX (206) 453-3199

Circle Reader Action No. 552

GAE-Graphics/PC RELEASES THE MAINFRAME IN YOUR PC



- A VERSATILE GRAPHICS SUBROUTINE LIBRARY FOR MICROCOMPUTER.
- INTERFACES WITH OVER 120 COMMON GRAPHICS DEVICES.
- PROVIDES ROUTINES TO GENERATE XY CHARTS, SURFACES, CONTOURS, 2- AND 3- DIMENSIONAL DESIGNS.
- COMPATIBLE AND TESTED UNDER LAHEY (F77L-EM/32), MICROSOFT, RYAN McFARLAND AND NDP FORTRAN.
- WORKS UNDER OS/2 AND MICROSOFT WINDOWS 3.0.

GAE

GALAXY APPLIED ENGINEERING, INC.
770 AIRPORT BOULEVARD
BURLINGAME, CALIFORNIA 94010
TEL (415) 347-9953
FAX (415) 347-9536

POLYMERS
Correlating DSC and x-ray measurements of crystallinity
Sep page 77 NPO-17958

POLYVINYL FLUORIDE
Correlating DSC and x-ray measurements of crystallinity
Sep page 77 NPO-17958

POROUS MATERIALS
Chemically layered porous solids
Oct page 45 MSC-21487

POSITION INDICATORS
Improved rotary transformer for shaft-position indicator
Apr page 30 NPO-17169

Three-dimensional moire pattern
Apr page 97 MSC-21416

POSITION (LOCATION)
Matching terrain-height maps for a robotic vehicle
Oct page 108 NPO-17856

POSITION SENSING
Electro-optical position-measuring system
Jan page 26 LAR-13840

POSITIONING DEVICES (MACHINERY)
Jig for compression-relaxation tests of plastics
May page 53 MSC-21674

POTABLE WATER
Source and sink of iodine for drinking water
Oct page 116 MSC-21739

POTENTIOMETERS (INSTRUMENTS)
Device measures angle of deployment
Apr page 36 GSC-13351

POWDER (PARTICLES)
Measuring electrical resistivity of compacted powder
Nov page 58 NPO-18056

POWER CONVERTERS
Dc-to-dc converter uses reverse conduction of MOSFET's
Mar page 22 LEW-14944

POWER SUPPLY CIRCUITS
Switched-capacitor voltage multiplier
Aug page 16 NPO-17994

POWERED LIFT AIRCRAFT
Analyzing takeoffs of powered-lift aircraft
Oct page 83 ARC-11784

PRECIPITATION (CHEMISTRY)
Integrated protein-crystal-growing apparatus
Jul page 90 MFS-28422

Thermosyphon suspension for growth of crystals
Jul page 82 MFS-26113

PREFORMS
Farley three-dimensional-braiding machine
Mar page 60 LAR-13911

Computer-aided design of sheet-material parts
Aug page 83 MFS-29759

PREPREGS
Vacuum powder injector
Oct page 93 LAR-14179

PROGRAMMING LANGUAGES
General-purpose Ada software packages
Feb page 51 NPO-17983

Source-code-analyzing program
Mar page 46 GSC-13268

Ada namelist package
May page 50 NPO-17984

Computer language for optimization of design
Aug page 59 LAR-14280

PRESSURE MEASUREMENT
Adjustable pitot probe
Aug page 70 LAR-14232

PRESSURE REGULATORS
Reed valve regulates welding back-purge pressure
Jul page 81 MFS-29684

Rotary-to-axial motion converter for valve
Oct page 76 MSC-21697/8

PRESSURE SENSORS
Calculation of pneumatic attenuation in pressure sensors
Mar page 47 ARC-12210

PRESSURE VESSELS
Quick-acting closure and handling system
Mar page 54 LAR-13774

Penetrable linear-gap pressure seal
Jul page 70 LEW-14965

PRESTRESSING
Deflection and stress in preloaded square membrane
Sep page 96 GSC-13367

PRIMARY BATTERIES
Vaporization would cool primary battery
Sep page 90 NPO-17805

PRIMATES
Processing of visual information in primate brains
Mar page 67 NPO-17900

PRIMERS (EXPLOSIVES)
Apparatus for tests of percussive primers
Jan page 42 LAR-13996

PRINTERS
Interface circuit for printer port
Jun page 26 LAR-13950

PROBABILITY DENSITY FUNCTIONS
Estimating confidence in data via trend analysis
Mar page 63 MFS-29710

PROBES
Contact probe with pivoting tip
Nov page 77 MFS-28536

PROBLEM SOLVING
Solving constraint-satisfaction problems in prolog language
Nov page 101 ARC-12460

PRODUCT DEVELOPMENT
Estimating the cost of developing software
Feb page 48 NPO-17936

PROFILOMETERS
Weld-bead profilometer rejects optical noise
Apr page 40 MFS-26115

Computerized profilometer for inspection of welds
Aug page 79 MFS-28548

PROGRAMMING LANGUAGES
General-purpose Ada software packages
Feb page 51 NPO-17983

Source-code-analyzing program
Mar page 46 GSC-13268

Ada namelist package
May page 50 NPO-17984

Computer language for optimization of design
Aug page 59 LAR-14280

Circle Reader Action No. 406

Multiple Pages Intentionally Left
Blank

1991 Annual Subject Index

Library of subprograms in FORTRAN 77
Dec page 55 NPO-18120

PROJECTILES
Superconducting magnetic projectile launcher
Mar page 48 NPO-17746

PROLOG (PROGRAMMING LANGUAGE)

Solving constraint-satisfaction problems in prolog language
Nov page 101 ARC-12460

PROPELLENTS

Apparatus for tests of percussion primers
Jan page 42 LAR-13996

PROPULSION

Electromagnetic gun with commutated coils
Apr page 26 NPO-17839

PROSTHETIC DEVICES

Prosthetic hand lifts heavy loads
Feb page 69 MFS-28465

Rotationally actuated prosthetic hand
Feb page 69 MFS-28426

Neural-network control of prosthetic and robotic hands
Oct page 28 MSC-21642

PROTECTIVE CLOTHING

Garment would provide variable cooling
Jul page 44 MSC-21531

PROTECTIVE COATINGS

Protecting helmets and visors from chemicals
Apr page 70 MSC-21503

SiO₂ protective coat for polyimide sheet
Apr page 73 LEW-14912

PROTEINS
Electrostatic stabilization of growing protein crystals
Mar page 35 NPO-17747

Integrated protein-crystal-growing apparatus
Jul page 90 MFS-28422

Thermosyphon suspension for growth of crystals
Jul page 82 MFS-26113

Compact apparatus for growth of protein crystals
Aug page 51 MFS-28507

PULSE COMMUNICATION
Burst-compression and-expansion for TDMA communication
Jun page 40 LEW-15102

PULSE WIDTH AMPLITUDE CONVERTERS
Dc-to-dc converter uses reverse conduction of MOSFET's
Mar page 22 LEW-14944

PULLING
Reusable mechanical pin puller
Sep page 97 GSC-13355

PULSE DURATION MODULATION
Pulse-width-modulating driver for brushless dc motor
Sep page 18 NPO-17142

PUMPS
Jet boost pumps for the Space Shuttle main engine
May page 58 MFS-29673

TEM pump with external heat source and sink
Jul page 79 NPO-17864

PYROLYSIS
Silane-pyrolysis reactor with nonuniform heating
Jun page 104 NPO-17932

FLUIDIZED-BED SILANE-DECOMPOSITION REACTOR
Nov page 63 NPO-18014

Q
QUALITY CONTROL
Addressable-matrix integrated-circuit test structure
Nov page 32 NPO-18162

QUANTUM WELLS
Multiple-quantum-well intersubband infrared detector
Jan page 25 NPO-17962

QUINOXALINES
Polyphenylquinoxalines via aromatic nucleophilic displacement
Jan page 32 LAR-13988

R
RADAR IMAGERY
Ambiguity of Doppler centroid in synthetic-aperture radar
Nov page 48 NPO-17943

RADAR SCATTERING
Azimuthal anisotropy in radar backscatter from the ocean
Sep page 79 NPO-17422

Radar backscatter from the ocean at low windspeeds
Sep page 79 NPO-18036

RADIATION DETECTORS
Hole-impeded-doping-superlattice LWIR detectors
Sep page 22 NPO-17880

Characterization of electrical response of photodetector
Dec page 24 GSC-13349

RADIATION DISTRIBUTION
Reducing cross-polarized radiation from a microstrip antenna
Aug page 20 NPO-18147

RADIATIVE TRANSFER
Effects of interference on scattering by parallel fibers
Nov page 60 ARC-12530

RADIO ANTENNAS
End-loaded, cavity-backed, cross-slot antennas
Sep page 30 NPO-18100

RADIO BURSTS
Burst-compression and-expansion for TDMA communication
Jun page 40 LEW-15102

RADIO COMMUNICATION
Simultaneous detection and estimation amid strong dynamical effects
Jan page 28 NPO-17820

RADIO FREQUENCIES
Two-dimensional acousto-optical spectrum analyzer
Sep page 72 NPO-18092

RADIO SIGNALS
Multiple-symbol differential detection of MPSK
Mar page 30 NPO-17896

Transmitting reference radio signal on two optical carriers
Jun page 32 NPO-18007

System acquires and displays signal-propagation data
Sep page 64 NPO-18190

RADIO TRANSMITTERS
Expert system for heat exchanger
Oct page 90 NPO-17991

RADIOGRAPHY
Radiographic detection of voids in SiC and SiN ceramics
Jan page 34 LEW-14881

Verifying x-radiographs with computed tomographs
Jun page 116 MFS-29649

RADIOISOTOPE BATTERIES
Betavoltaics of increased power
Aug page 23 NPO-17817

RADIOMETERS
Improving sparse-aperture interferometric radiometry
Mar page 26 NPO-17886

Proceedings of infrared-detector workshop
Nov page 60 ARC-12851

RANDOM ACCESS MEMORY
Self-testing static random-access memory
Feb page 30 NPO-17939

Fast magnetoresistive random-access memory
Apr page 32 NPO-17954

Magnet/Hall-effect random-access memory
Nov page 28 NPO-17999

Magnetic analog random-access memory
Nov page 30 NPO-17998

RANGE FINDERS
Three-dimensional moire pattern
Apr page 97 MSC-21416

RANGEFINDING
Optoelectronic ranging sensor for robotic vehicle
Mar page 26 NPO-17959

REAL GASES
Real-gas properties of air and air-plus-hydrogen mixtures

Jan page 30 ARC-12275

RECLAMATION
Plasma spraying reclaims compressor housings
Jan page 44 LEW-14899

RECORDING
Video recording of images in laser remote sensing
Jul page 26 GSC-13398

RECOVERY PARACHUTES
Selectable-towline spin-chute system
Nov page 84 LAR-14322

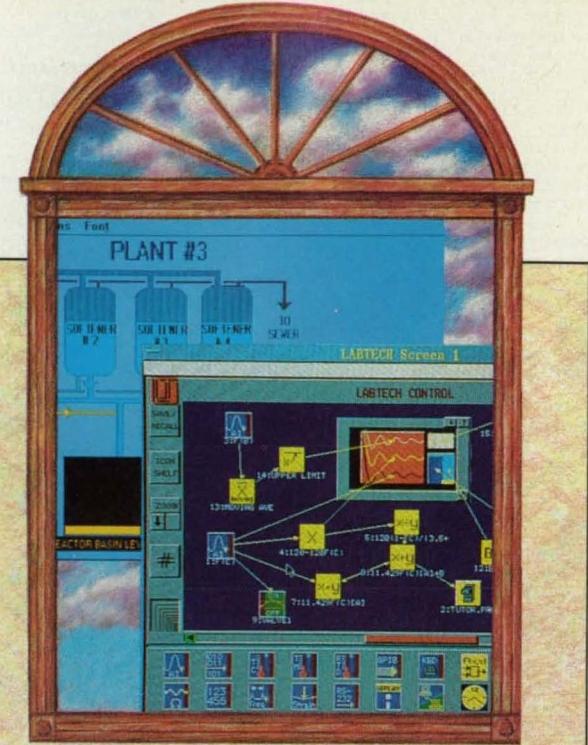
RECURSIVE FUNCTIONS
Recursive inversion by finite-impulse-response filters
Jan page 51 ARC-12247

REDUCED GRAVITY
Microgravity experiments on animals
Apr page 101 ARC-12343

Initiating growth of crystals away from container walls
Sep page 106 MFS-28473

Variable-speed instrumented centrifuges
Sep page 101 KSC-11383

Separation of liquid and gas in zero gravity
Oct page 91 KSC-11387



LABTECH® Opens Windows

NOTEBOOK™ and CONTROL™ Run Under Windows and X-Windows

Now...LABTECH NOTEBOOK, our general-purpose data acquisition, analysis, and control software, along with LT/CONTROL, the process monitoring and control software from our Industrial Products Division, supports both Microsoft Windows™ and X-Windows™.

With this advance, LABTECH lets you take advantage of all the features of Windows software, including multitasking, whether you are using a PC or a UNIX or VMS workstation.

Our software is available for the widest selection of operating environments and I/O devices. LABTECH is dedicated to cross-platform compatibility. If you change computers, you can also transfer your LABTECH software.

Opening Windows while maintaining that compatibility...another example of our commitment to protecting your software investment. Of course, LABTECH software is still available for MS-DOS and OS/2.

For more information, call or fax:

LABTECH

400 Research Drive
Wilmington, MA 01887
Tel.: 508/657-5400
Fax: 508/658-9972

The products mentioned above are trademarks of their respective companies.

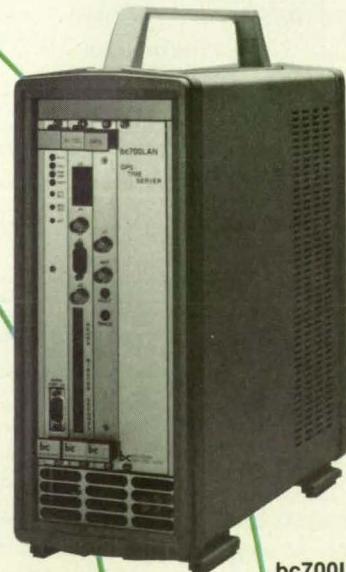
REFERENCE ATMOSPHERES Global reference atmosphere model—1988 Jan page 35 MFS-28397	REFRACTORY COATINGS High-temperature insulating gap filler Jul page 52 MSC-21644	Concentric regenerative sorption compressor Jun page 100 NPO-17877	REMOTE HANDLING Segmented arm for positioning and assembly May page 58 MSC-21512	Viselike robotic gripper Oct page 86 GSC-13323	Sensing temperatures via prostheses and manipulators Oct page 35 MSC-21676
REFLECTING TELESCOPES Optical modeling of segmented mirror telescopes Mar page 36 NPO-17961	REFRACTORY MATERIALS Silicon carbide threads for high-temperature service Apr page 64 ARC-12406	Stereoscopic configurations to minimize distortions Feb page 34 NPO-18028	REMOTE SENSING Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	Removing ambiguities in remotely sensed winds Nov page 99 NPO-18079	
System would keep telescope reflector segments aligned Apr page 40 NPO-17903	Iridium/rhenium parts for rocket engines Jul page 54 LEW-14924	Direct-link prehensor Dec page 78 ARC-11666	REMOTE MANIPULATOR SYSTEM Status of imaging radar polarimetry Jan page 30 NPO-17890	Spaceborne microwave imagers Dec page 42 NPO-17094	
Development of composite panels for telescope mirrors Oct page 100 NPO-17895	REFRIGERATING Reversible chemisorption gas-gap thermal switch Nov page 54 NPO-17568	Active compliance and damping in telemannipulator control Apr page 48 NPO-17969	REMOTE SENSORS Measuring wildfires from aircraft and satellites Feb page 40 ARC-12132	Airborne laser polarization sensor Feb page 34 GSC-13314	
REFLECTOR ANTENNAS Fast approximate analysis of modified antenna structure Mar page 64 NPO-17901	REFRIGERATING MACHINERY Sorption compressor with rotary regenerator Jun page 101 NPO-17876	Anthropomorphic remote manipulator Apr page 92 NPO-17975	Estimating the SNR of AVIRIS data Feb page 66 ARC-12361	Reduced-wiring tactile sensor Mar page 18 NPO-17872	
Analyzing large reflector antenna structures Apr page 77 NPO-17783	REFRIGERATORS Oscillating thermal switch Feb page 34 NPO-17125	Compact force-reflecting hand controller Apr page 88 NPO-17851	Polarization filtering of SAR data Apr page 58 NPO-17904	REPRESENTATIONS State-variable representations for moving-average sampling Jan page 48 MFS-28405	
Caustic singularities of high-gain, dual-shaped reflectors Apr page 38 NPO-18046	Regenerative sorption refrigerator Mar page 51 NPO-17630	Developing confidence limits for reliability of software Nov page 102 LAR-14292	Microwave brightness of land surfaces from outer space May page 34 NPO-17739	RESEARCH FACILITIES Research animal holding facility prevents space lab contamination Aug page 89 ARC-12599	
REFLECTORS Semiconductor laser with multilayer dielectric reflector Feb page 18 NPO-17763	Mixed-gas sorption Joule-Thomson refrigerator May page 38 NPO-17569	Efficient computation of inertia matrix of a manipulator May page 70 NPO-17545	Airborne calibration of an orbiting radiometer Jun page 48 ARC-12617	RESIN MATRIX COMPOSITES Polyamide-imides made from BTDA May page 48 LAR-13942	
Solar concentrator has wider cone of acceptance Apr page 56 MFS-28295	REGENERATIVE COOLING Sorption compressor with rotary regenerator Jun page 101 NPO-17876	Analysis of control of cooperating robot arms Jul page 86 NPO-17789	Video recording of images in laser remote sensing Jul page 26 GSC-13398	LaRC-RP41: a tough, high-performance composite matrix Sep page 82 LAR-14338	
Conical mirrors for quasi-retroreflection Nov page 54 NPO-18005	REGENERATORS Two-phase bidirectional heat exchanger Mar page 49 GSC-13287	Parallel-processing algorithms for dynamics of manipulators Sep page 111 NPO-17718	Azimuthal anisotropy in radar backscatter from the ocean Sep page 79 NPO-17422	RESINS Phenylated polyimides with greater solubility Oct page 46 LAR-14170	
	REMOTE CONTROL Generalized covariance analysis for remote estimates Jan page 52 NPO-17824	Grasping-force sensor for robot hand Oct page 72 NPO-16647	Circuit detects faint flashes against bright background Sep page 19 MFS-28466		
		Redundant robot can avoid obstacles Oct page 86 NPO-17852	Improved radiometric correction for SAR images Oct page 37 NPO-17931		

XII**GPS TIME FOR YOUR NETWORK**

The bc700LAN GPS Network Time Server receives time from the Global Positioning System (GPS) satellite constellation, maintaining a high precision (100 nanosecond) primary local time standard. Client workstations synchronize their clocks to this local standard using the Internet Network Time Protocol.

In addition to network time service, IRIG Time Code and Digital Synchronization signals are available.

- Millisecond Resolution on LAN
- Microsecond Resolution with IRIG Time Code.
- Internet Protocols



FROM THE MASTERS OF TIME



BANCOMM, DIVISION OF DATUM INC
6541 Via del Oro, San Jose, CA 95119

TEL: (408) 578-4161
FAX: (408) 578-4165

1991 Annual Subject Index

RESISTORS	Self-motion manifolds of redundant manipulators Sep page 101 NPO-17965	ROTATING LIQUIDS	Calculating scattering at circular-waveguide junctions Jul page 20 NPO-17288	Circuit for current-vs.-voltage tests of semiconductors Apr page 24 MFS-29623	SERVOCONTROL
Cross-quint-bridge resistor Jun page 28 NPO-18106		ROTATING MIRRORS	Radar backscatter from the ocean at low windspeeds Sep page 79 NPO-18036	Doping to reduce base resistances of bipolar transistors May page 22 NPO-17948	Mode-switching algorithms for antenna servocontroller Sep page 56 NPO-17489
Resistor extends life of battery in clocked CMOS circuit Sep page 29 NPO-17967	Expert script generator Oct page 70 LAR-14065	ROTATING MIRRORS	Closed-loop chopping-mirror controller Sep page 50 ARC-11177		Servo reduces friction in flexure bearing Nov page 74 LAR-14349
RESONATORS	Grasping-force sensor for robot hand Oct page 72 NPO-16647	ROTATING SHAFTS	Improved rotary transformer for shaft-position indicator Apr page 30 NPO-17169	SCATTERING	SET THEORY
Quasi-optical millimeter-wavelength resonator Jun page 16 NPO-17919	Matching terrain-height maps for a robotic vehicle Oct page 108 NPO-17856	ROTATING SHAFTS	Improved rotary transformer for shaft-position indicator Apr page 30 NPO-17169	Calculating scattering at circular-waveguide junctions Jul page 20 NPO-17288	Algorithm for solution of subset-regression problems Feb page 66 ARC-12145
Sapphire ring resonator for microwave oscillator Sep page 20 NPO-18082	Neural-network control of prosthetic and robotic hands Oct page 28 MSC-21642	ROTATING SHAFTS	Optoelectronic shaft-angle encoder tolerates misalignments Apr page 47 GSC-13175	SCATTEROMETERS	SHAFTS (MACHINE ELEMENTS)
RETINA	Redundant robot can avoid obstacles Oct page 86 NPO-17852	ROTATION	Synchronizing rotation of a heavy load Jun page 103 GSC-13325	Radar backscatter from the ocean at low windspeeds Sep page 79 NPO-18036	Noncontact measurements of torques in shafts Mar page 50 MFS-29717
Portable video/digital retinal funduscope Sep page 115 MSC-21675	Software for integration of EVA and telerobotics Oct page 69 NPO-18220	ROTATION	Modification of catadioptric telescope for laser velocimetry Aug page 56 ARC-12610	SCHEDULING	Thin, lightweight solar cell May page 20 LEW-14959
Compensating for movement of eye in laser surgery Nov page 46 MSC-21509	Software for supervisory and shared control of a robot Oct page 102 NPO-18116	ROTOR AERODYNAMICS	Optical shaft-angle encoder tolerates misalignments Apr page 47 GSC-13175	Automated scheduling via artificial intelligence Aug page 86 NPO-18209	Growing cobalt silicide columns in silicon Jun page 121 NPO-17835
RETROREFLECTION	Testbed for telerobotic servicing Oct page 32 NPO-18061	ROTORS	Synchronizing rotation of a helicopter rotor May page 55 ARC-12202	SCHMIDT TELESCOPES	SHAPES
Conical mirrors for quasi-retroreflection Nov page 54 NPO-18005	Viselike robotic gripper Oct page 86 GSC-13323	ROBOTS	Calculating flow through a helicopter rotor May page 55 ARC-12202	Modification of catadioptric telescope for laser velocimetry Aug page 56 ARC-12610	Optical shaft-angle encoder tolerates misalignments Apr page 47 GSC-13175
REVIEWING	Robot grasps rotating object Sep page 58 NPO-18016	ROBOTS	Optoelectronic remote manipulator Apr page 92 NPO-17975	SCHOTTKY DIODES	Improved rotary transformer for shaft-position indicator Apr page 30 NPO-17169
Systematic identification of discrepant hardware Jun page 58 MFS-29525	System for research on multiple-arm robots Oct page 30 NPO-17971	ROBOTS	Anthropomorphic remote manipulator Apr page 92 NPO-17975	Improved planar Schottky diode May page 24 GSC-13205	Optoelectronic shaft-angle encoder tolerates misalignments Apr page 47 GSC-13175
REYNOLDS STRESS	Robot grasps rotating object Sep page 58 NPO-18016	ROVING VEHICLES	Planning the route of a robotic land vehicle Mar page 61 NPO-17857	SCHOTTKY DIODES	Proceedings of infrared-detector workshop Nov page 60 ARC-12851
Analysis of turbulence in a simple shear flow Apr page 84 NPO-17374	System for research on multiple-arm robots Oct page 30 NPO-17971	ROVING VEHICLES	Optoelectronic ranging sensor for robotic vehicle Mar page 26 NPO-17959	SCHEMATIC	Repairing a shaft prone to fatigue Oct page 94 MFS-28518
RHENIUM	Robot grasps rotating object Sep page 58 NPO-18016	ROVING VEHICLES	Planning the route of a robotic land vehicle Mar page 61 NPO-17857	SCHEMATIC	SHAPE MEMORY ALLOYS
Iridium/rhenium parts for rocket engines Jul page 54 LEW-14924	System for research on multiple-arm robots Oct page 30 NPO-17971	ROVING VEHICLES	Optoelectronic ranging sensor for robotic vehicle Mar page 26 NPO-17959	Long-lifetime laser materials for effective diode pumping Feb page 42 LAR-13807	Lightweight memory-metal pin puller Jul page 69 NPO-18131
RIVETS	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROVING VEHICLES	Planning the route of a robotic land vehicle Mar page 61 NPO-17857	SCORING	SHEAR FLOW
Designing applications for fasteners Oct page 101 LEW-15081	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROVING VEHICLES	Optoelectronic ranging sensor for robotic vehicle Mar page 26 NPO-17959	Grit blasting scribes coats for tests of adhesion Jul page 84 MFS-28452	Analysis of turbulence in a simple shear flow Apr page 84 NPO-17374
ROBOTICS	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROVING VEHICLES	Planning the route of a robotic land vehicle Mar page 61 NPO-17857	SCORING	SHEATHS
Algorithmically specialized parallel architecture for robotics Feb page 22 NPO-17632	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROVING VEHICLES	Optoelectronic ranging sensor for robotic vehicle Mar page 26 NPO-17959	Improved planar Schottky diode May page 24 GSC-13205	Intramuscular contact lead filled with conductive solution May page 74 NPO-17186
Planning the route of a robotic land vehicle Mar page 61 NPO-17857	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROVING VEHICLES	Planning the route of a robotic land vehicle Mar page 61 NPO-17857	SCREWS	SHELLS (STRUCTURAL FORMS)
Reduced-wiring tactile sensor Mar page 18 NPO-17872	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROVING VEHICLES	Optoelectronic ranging sensor for robotic vehicle Mar page 26 NPO-17959	Lockwasher strongly resists disassembly Nov page 93 MFS-29696	Fully-stressed-design algorithm for plate/shell structures Nov page 75 ARC-12687
Compact force-reflecting hand controller Apr page 88 NPO-17851	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROVING VEHICLES	Planning the route of a robotic land vehicle Mar page 61 NPO-17857	SCREWS	SHOCK WAVES
Segmented arm for positioning and assembly May page 58 MSC-21512	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROVING VEHICLES	Optoelectronic ranging sensor for robotic vehicle Mar page 26 NPO-17959	Lockwasher strongly resists disassembly Nov page 93 MFS-29696	High-resolution numerical simulation of shock waves Jul page 74 ARC-11730
Tool for robotic resistive roll welding May page 62 MFS-29660	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	RODENTS	Research animal holding facility prevents space lab contamination Aug page 89 ARC-12599	SEALS	Overview of methods for computation of shocks Jul page 74 ARC-12667
Analysis of control of cooperating robot arms Jul page 86 NPO-17789	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	RODENTS	Research animal holding facility prevents space lab contamination Aug page 89 ARC-12599	SEALS (STOPPERS)	SHORT TAKEOFF AIRCRAFT
Architecture for intelligent control of robotic tasks Aug page 28 NPO-17871	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	RODENTS	Research animal holding facility prevents space lab contamination Aug page 89 ARC-12599	O-ring-testing fixture Feb page 54 MFS-28414	Analyzing takeoffs of powered-lift aircraft Oct page 83 ARC-11784
Experiences with the JPL telerobot testbed Aug page 30 NPO-17928	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROLLERS	Pressure roller for tape-lift tests Sep page 105 GSC-13230	SEALS (STOPPERS)	SHROUDS
Spatial-operator algebra for robotic manipulators Aug page 88 NPO-17770	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROLLERS	Pressure roller for tape-lift tests Sep page 105 GSC-13230	O-ring-testing fixture Feb page 54 MFS-28414	Preventing chemical-vapor deposition in selected areas Jun page 122 LAR-14300
Verification of tooling for robotic welding Aug page 85 MFS-29725	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTARY WINGS	Holographic interferometry to measure three-dimensional flow Jun page 60 ARC-11474	SEALS (STOPPERS)	SIGNAL ANALYSIS
Anthropomorphic robot hand and teaching glove Sep page 99 GSC-13244	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTARY WINGS	Holographic interferometry to measure three-dimensional flow Jun page 60 ARC-11474	O-ring-testing fixture Feb page 54 MFS-28414	Algorithm reveals sinusoidal component of noisy signal Dec page 86 MFS-29688
Transonic aeroelasticity analysis for helicopter rotor blade Jun page 60 ARC-12550	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTARY WINGS	Transonic aeroelasticity analysis for helicopter rotor blade Jun page 60 ARC-12550	SEALS (STOPPERS)	SIGNAL ENCODING
Investigation of tapered tension/torsion strap Dec page 68 ARC-12480	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTARY WINGS	Transonic aeroelasticity analysis for helicopter rotor blade Jun page 60 ARC-12550	O-ring-testing fixture Feb page 54 MFS-28414	Interleaving would enhance trellis-coded modulation Jan page 52 NPO-17899
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Block Lanczos algorithm for gyroscopic systems Aug page 75 ARC-12147	SEALS (STOPPERS)	SIGNAL GENERATORS
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	O-ring-testing fixture Feb page 54 MFS-28414	Waveform-generating program Sep page 87 MFS-28408
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	Flexible generation of array-detector timing signals Oct page 35 GSC-13345
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Robot grasps rotating object Sep page 58 NPO-18016	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	
Unbalanced rotating masses for scanning Sep page 100 MFS-28425	Fast parallel computation of manipulator inverse dynamics Dec page 89 NPO-18080	ROTATING BODIES	Robot grasps rotating object Sep page 58 NPO-18016	SEALS (STOPPERS)	</

EXPANDING LAPTOP POWER

 CONTEC

DATA ACQUISITION, CONTROL, AND COMMUNICATION BOARDS for LAPTOPS



CONTEC, a 16-year pioneer in the development and production of personal computer based data acquisition systems, now offers a new family of products for data acquisition, control, and communication on ISA bus laptop computers.

CONTEC has utilized state-of-the-art technology of miniaturization and surface mount components to pack as many functions as possible on half-size boards. This family includes digital, analog, and communication boards supported by drivers in Basic, C, Turbo Pascal, and LabTech Notebook.

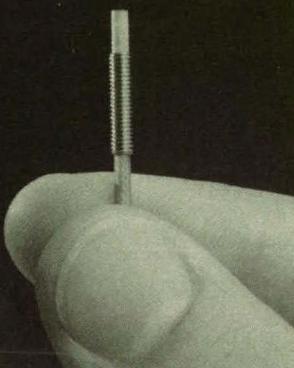
Backed by CONTEC's 3-year warranty, 30-day evaluation and free technical support, these products are ready to solve your data acquisition needs.

For more information, contact

CONTEC Microelectronics USA Inc.
2188 Bering Drive, San Jose, CA 95131
(800) 888-8884 FAX: (408) 434-6884

Circle Reader Action No. 440

Smallest position sensor ever



For even the tightest installations, Kaman's 0.080-inch diameter sensor lets you resolve microscopic displacements down to 4 micro-inches at 50 kHz — without contact. Ideal for both magnetic and non-magnetic materials, the KD-2300 is only one of Kaman's 24 standard sensors that let you see small changes in position without touching the target. Whether you want single-channel or multi-channel output, Kaman can meet your needs. Call us for details.

Kaman Instrumentation Corporation, 1500 Garden of the Gods Road, Colorado Springs, CO 80907. Phone 719-599-1825. FAX 719-599-1823.
1-800-552-6267

KAMAN

Circle Reader Action No. 472

SIGNAL PROCESSING

Digital signal combiner for receiving-antenna feed array
Jun page 32 NPO-18140

SIGNAL RECEPTION

Multiple-symbol differential detection of MPSK
Mar page 30 NPO-17896

SIGNAL TO NOISE RATIOS

Estimating the SNR of AVIRIS data
Feb page 66 ARC-12361

SIGNAL TRANSMISSION

Processor reformats data for transmission in bursts
Jun page 36 MSC-21727

SILANES

Silane-pyrolysis reactor with nonuniform heating
Jun page 104 NPO-17932

SILICATES

Copper-exchanged zeolite traps oxygen
Sep page 86 NPO-17761

SILICIDES

Molecular-beam epitaxy of IrSi₃
Feb page 60 NPO-17953

SILICON

Making ultrathin solar cells
Jan page 46 NPO-17798

Modified furnace makes more silicon ribbon
Feb page 64 NPO-17350

Growing cobalt silicide columns in silicon
Jun page 121 NPO-17835

Fluidized-bed silane-decomposition reactor
Nov page 63 NPO-18014

SILICON CARBIDES

Preventing vapor deposition on the backs of substrates
Jan page 44 LAR-14071

Silicon carbide threads for high-temperature service
Apr page 64 ARC-12406

Fabrication of lightweight mirrors via CVD
Jun page 122 LAR-14299

Preventing chemical-vapor deposition in selected areas
Jun page 122 LAR-14300

SILICON NITRIDES

Coating solar cells by microwave plasma deposition
May page 60 NPO-17035

SILICON OXIDES

SiO_x protective coat for polyimide sheet
Apr page 73 LEW-14912

SILICON RADIATION DETECTORS

Low-thermal-conduction links for silicon sensors
Feb page 38 GSC-13321

Si_xGe_y/Si infrared photodiodes

Oct page 26 NPO-17950

Si/IrSi₃ Schottky-barrier infrared detectors

Dec page 22 NPO-18027/17946

SIMULATION

Displaying computer simulations of physical phenomena
Feb page 32 ARC-12502

SINE WAVES

Half-tone video images of drifting sinusoidal gratings
Apr page 46 ARC-12414

SINGLE EVENT UPSETS

Multiple-bit errors caused by single ions
Jul page 38 NPO-18075

SKIN FRICTION

Polymers and ripples reduce hydrodynamic skin friction
Oct page 77 LAR-14271

SLOTTED WIND TUNNELS

Experiments on schemes for adaptive-wall wind tunnels
Dec page 72 ARC-12116

SLURRIES

Phase transformations in mullite-precursor xerogels
Feb page 44 LEW-14898

SOFTWARE ENGINEERING

Software for simulation of development of software
Dec page 56 NPO-18295

SOFTWARE TOOLS

YAMM—yet another menu manager
Feb page 47 NPO-17769

SILICON

Another program for generating interactive graphics
Jul page 65 GSC-13276

Program for generating interactive displays
Jul page 64 GSC-13275

Computing availability and reliability for a system
Nov page 70 NPO-18051

Developing confidence limits for reliability of software
Nov page 102 LAR-14292

Software-design-analyzer system
Dec page 57 NPO-18212

SOLAR CELLS

Making ultrathin solar cells
Jan page 46 NPO-17798

V-grooved GaAs solar cell
Feb page 16 LEW-14954

Device measures angle of deployment
Apr page 36 GSC-13351

SILICON NITRIDES

Coating solar cells by microwave plasma deposition
May page 60 NPO-17035

Thin, lightweight solar cell
May page 20 LEW-14959

Solar-cell cover glass would reduce reflectance loss
Jul page 22 LAR-14942

SOLAR COLLECTORS

Solar concentrator has wider cone of acceptance
Apr page 56 MFS-28295

Script-factor modeling of absorption in a solar receiver
Dec page 40 NPO-18018

SOLAR GENERATORS

Self-oscillating inductive boost regulator
Jan page 24 GSC-13305

SOLAR WIND

Effects of multiple ion species on plasma instabilities
Jul page 50 NPO-17771

1991 Annual Subject Index

SOLID ELECTROLYTES

Stacking oxygen-separation cells
Jun page 118 NPO-17223

SOLID LUBRICANTS

Low-wear ball-bearing separator
Feb page 56 MFS-29666

SOLID STATE DEVICES

Edge-geometry NbN/MgO/NbN tunnel junctions
Oct page 18 NPO-17812

Altering interline transfer in CCD to reduce saturation
Dec page 30 NPO-17935

SOLID STATE LASERS

Computing temperatures in optically pumped laser rods
Jul page 63 LAR-14209

Self-heterodyne laser-spectrum analyzer
Sep page 66 GSC-13397

Two-period gratings for surface-emitting lasers
Dec page 26 NPO-18054

SOLVENTS

Hot oil removes wax
Feb page 60 MFS-29713

SOOT

Mathematical model for deposition of soot
Aug page 49 MFS-28506

SORPTION

Regenerative sorption refrigerator
Mar page 51 NPO-17630

Mixed-gas sorption Joule-Thomson refrigerator
May page 38 NPO-17569

Concentric regenerative sorption compressor
Jun page 100 NPO-17877

Sorption compressor with rotary regenerator
Jun page 101 NPO-17876

Reversible chemisorption gas-gap thermal switch
Nov page 54 NPO-17568

SOURCE PROGRAMS

Source-code-analyzing program
Mar page 46 GSC-13268

SOUTHERN HEMISPHERE
Nitrous oxide in the antarctic stratosphere
Apr page 63 ARC-12223

SPACE ADAPTATION SYNDROME

Instrument measures ocular counterrolling
Dec page 91 MSC-21711

SPACE COMMUNICATION
Behavior of Costas loop in reception of telemetry
Aug page 30 NPO-18084

SPACE LAB

Microgravity experiments on animals
Apr page 101 ARC-12343

More life-science experiments for Spacelab
Apr page 102 ARC-12316

SPACE MISSIONS

Graphical planning of spacecraft missions
Aug page 60 GSC-13318

SPACE PROCESSING

Electrostatic stabilization of growing protein crystals
Mar page 35 NPO-17747

Compact apparatus for growth of protein crystals
Aug page 51 MFS-28507

SPACE SHUTTLE BOOSTERS

Distributed-computer system optimizes SRB joints
Aug page 24 LAR-14311

Placement of O-rings in solid rocket booster
Aug page 76 NPO-18008

SPACE SHUTTLE MAIN ENGINE

Jet boost pumps for the Space Shuttle main engine
May page 58 MFS-29673

Stress stiffening of STAR-DYNE plate elements
Jul page 69 MFS-29738

SPACE SHUTTLES

Computed flow about the integrated space shuttle
Oct page 80 ARC-12685

SPACECRAFT

Carrying humans to and from Mars
Aug page 78 MFS-28453

SPACECRAFT COMMUNICATION

Multistage estimation of frequency and phase
Jan page 27 NPO-17911

Study of candidate architectures for data processor
Nov page 48 MSC-21690

SPACECRAFT DOCKING

Docking system with video feedback
Mar page 31 MFS-28421

More about video-feedback docking system
Oct page 36 MFS-28419

SPACECRAFT DOCKING MODULES

Docking system would accomodate misalignments
Aug page 68 MSC-21596

SPACECRAFT MANEUVERS

Plotting orbital trajectories for maneuvers
Oct page 68 ARC-12365

SPACECRAFT POWER SUPPLIES

Batovoltaics of increased power
Aug page 23 NPO-17817

SPACECRAFT TRAJECTORIES

Jacobi-integral method for two-body problem
May page 56 MSC-21623

SPARK MACHINING

Electrical-discharge machining with additional axis
Feb page 63 MFS-29630

SPATIAL FILTERING

Single-exposure long-equivalent-wavelength interferometry
Nov page 52 NPO-17580

SPECTRA

Calculating electronic spectra of diatomic molecules
Oct page 41 ARC-12412

SPECTRAL METHODS

Spectral method for simulation of vortex rings
Oct page 74 ARC-12639

SPECTROMETERS

Multiaperture spectrometer
Dec page 38 NPO-18011

SPECTRUM ANALYSIS

Self-heterodyne laser-spectrum analyzer
Sep page 66 GSC-13397

Three-dimensional acousto-optical spectrum analyzer
Sep page 62 NPO-18122

Two-dimensional acousto-optical spectrum analyzer
Sep page 72 NPO-18092

SPEED INDICATORS

Low-speed optical speedometer
Jun page 54 NPO-17702

SPILLING

Removing spilled oil with liquid nitrogen
Mar page 38 LAR-14227

SPlicing

Stiff, strong splice for a composite sandwich structure
Aug page 84 ARC-11743

SPOILERS

Leading-edge pop-up spoiler for airfoil
Mar page 52 LAR-13781

Flutter spoilers
Sep page 93 LAR-14117

Pneumatic spoiler controls airfoil lift
Nov page 71 ARC-11519

SPOT WELDS

Compact pinch welder
Jun page 109 MFS-29670

Spot-welding gun is easy to use
Jun page 119 MFS-29693

SPRayers

Portable water-saving shower for emergencies
Oct page 115 MFS-28459

SPRINGS (ELASTIC)

Tool removes coil-spring thread inserts
Jun page 106 MFS-28432

STAINLESS STEELS

Uniform-dead-weight brazing
Nov page 91 MSC-21627

STATISTICAL ANALYSIS

Generalized covariance analysis for remote estimates
Jan page 52 NPO-17824

Dynacounter electronic data-reduction system
Nov page 46 MSC-21568

STATISTICAL TESTS

Computing confidence limits
Mar page 46 MFS-29476

STEADY FLOW

Processing particle-streak imagery on a personal computer
Dec page 69 ARC-12267

STEPPING MOTORS

Meissner-effect stepping motor
Feb page 59 MFS-28409

STEREOSCOPY

Stereoscopic video weld-seam tracker
Mar page 29 MFS-26116

STEREOTELEVISION

Stereoscopic configurations to minimize distortions
Oct page 34 NPO-18028

STERILIZATION

Apparatus circulates sterilizing gas
Oct page 116 MSC-21552

STIRLING CYCLE

Stirling-cycle cooling for tunable diode laser
Aug page 16 NPO-18045

STORAGE BATTERIES

Reinforced positive filler paste for lead/acid batteries
Jan page 20 NPO-16991

Behavior of NbSe₃ cathode in rechargeable Li cell
Mar page 35 NPO-17648

Lightweight, high-energy lead/acid battery
Apr page 22 NPO-16962

Lithium cells accept hundreds of recharges
Jun page 28 NPO-17676

Lightweight fibrous Ni electrodes for Ni/H₂ batteries
Jul page 56 LEW-14955

STRAIN DISTRIBUTION

Strain center for analysis of forces
Aug page 68 NPO-17966

STRAIN GAGES

Improved force-and-torque sensor assembly
Sep page 95 NPO-17370

Grasping-force sensor for robot hand
Oct page 72 NPO-16647

Program calibrates strain gauges
Dec page 52 MSC-21399

STRAPS

Thermal strap and cushion for thermoelectric cooler
Jun page 16 NPO-17806

Investigation of tapered tension/torsion strap
Dec page 68 ARC-12480

STRATOSPHERE

Nitrous oxide in the antarctic stratosphere
Apr page 63 ARC-12223

STRESS ANALYSIS

Improved computation of dynamic stresses
Jan page 39 MFS-29745

Program analyzes errors in STAGS
Jan page 36 LAR-14063

Deflection and stress in preloaded square membrane
Sep page 96 GSC-13367

Software models impact stresses
Nov page 65 MFS-29628

STRESS CORROSION CRACKING

Grease inhibits stress-corrosion cracking in bearing race
Aug page 58 MFS-29664

STRESS RATIO

Fully-stressed-design algorithm for plate/shell structures
Nov page 75 ARC-12687

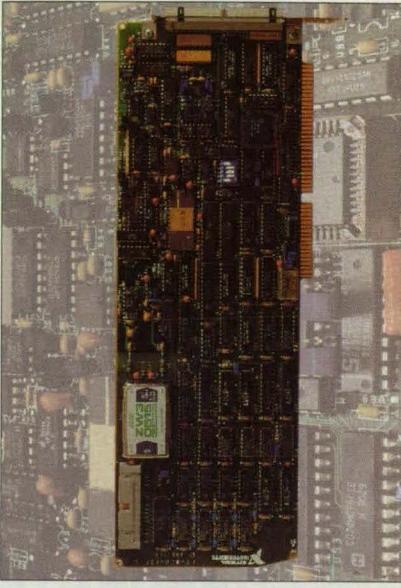
STRUCTURAL ANALYSIS

Norms and completeness in variational methods
May page 71 NPO-18071

Program for elastoplastic analyses of plane frames
Aug page 59 LEW-14889

DATA ACQUISITION

Setting the New Standard in PC Data Acquisition



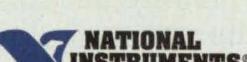
AT-MIO-16F-5 Hardware

- PC AT plug-in data acquisition board
- 200 ksamples/sec with 12-bit resolution at gains up to 100
- True self-calibration
- RTSI® bus for multiboard synchronization
- Software-configurable

NI-DAQ™ Software

- Driver for programming under DOS and Windows
- Included with board
- Over 100 comprehensive high-level I/O routines, data and buffer manager, and resource manager
- Includes DAQWare™ Getting-Started Software

Call for Free 1992 Catalog



6504 Bridge Point Parkway

Austin, TX 78730-5039

Tel: (512) 794 0100

(800) 433 3488

(U.S. and Canada)

Fax: (512) 794-8411

Branch Offices

AUSTRALIA 03 879 9422 • BELGIUM 02 757 00 02

CANADA 519 622 9310 • DENMARK 45 76 32 22

FRANCE 1 48 65 33 70 • GERMANY 089 714 5093

ITALY 02 4830 1892 • JAPAN 03 3788 1921

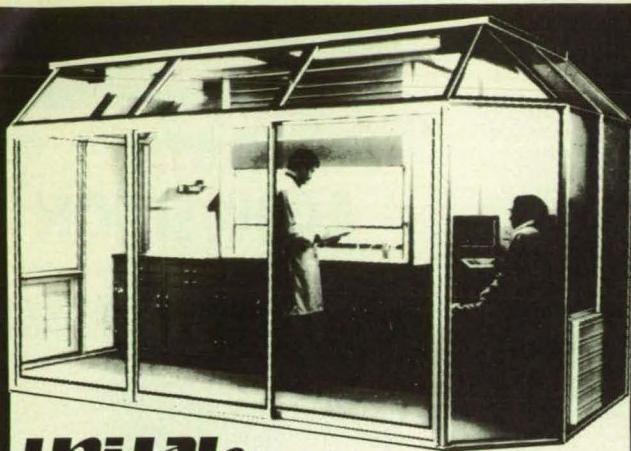
NETHERLANDS 01720 45761 • NORWAY 03 846866

SPAIN 900 604 304 • SWEDEN 984 570

SWITZERLAND 056 45 58 80 • U.K. 0635 523 545

Product names listed are trademarks of their respective manufacturers. Company names listed are trademarks or trade names of their respective companies.

© Copyright 1991 National Instruments Corporation. All rights reserved.



unilab

INNOVATIVE ENVIRONMENTAL ENCLOSURES FOR SCIENCE AND INDUSTRY

REGULATED WORK AREAS

- Pilot Plant Operations
- Environmental Enclosures
 - Clean Room Applications
 - Hazardous Procedures
 - NEW MOBILAB
 - NEW MODULAB

Request new catalog describing HEMCO's
Unilab Regulated Work Areas. call 816-796-2900



HEMCO
CORPORATION
111 N. Powell Independence, MO 64056 USA

Circle Reader Action No. 616

License to exceed normal limits



Zirconia Fiber-Based Materials offer limitless possibilities

When you need exceptionally high temperatures, low thermal conductivity or resistance to chemical attack, choose one of Zircar's Zirconia fiber-based materials. Bulk fibers, flexible textiles, rigid boards or cylinders: nobody knows how to take Zirconia to the limit like Zircar!

Zircar®
FIBROUS CERAMICS

P.O. Box 458, Florida, NY 10921
Tel: (914) 651-4481 Fax: (914) 651-3192

Circle Reader Action No. 323

Integrated analysis capability program
Dec page 54 GSC-13341

SURFACE LAYERS
Chemically layered porous solids
Oct page 45 MSC-21487

SYSTEMS ANALYSIS
Decomposing systems into subsystems for design
Oct page 69 LAR-14210

STRUCTURAL MEMBERS
Open-section composite structural elements
Feb page 45 MFS-26112

SURFACE PROPERTIES
Ion processes modify tribological properties of surfaces
Apr page 96 LEW-14865

T
Computing availability and reliability for a system
Nov page 70 NPO-18051

STRUCTURAL VIBRATION
Calculating transient vibrations of coupled substructures
May page 54 MFS-28477

SURFACE VEHICLES
Planning the route of a robotic land vehicle
Mar page 61 NPO-17857

TACTILE DISCRIMINATION
Reduced-wiring tactile sensor
Mar page 18 NPO-17872

Two techniques for suppressing vibrations in structures
Dec page 60 NPO-17889

SUSPENDING (HANGING)
Low-frequency suspension system for large space structures
Jun page 62 LAR-14149

TAKEOFF
Analyzing takeoffs of powered-lift aircraft
Oct page 83 ARC-11784

STRUTS
Composite struts would damp vibrations
Apr page 79 NPO-17914

Zero-spring-rate mechanism/air suspension cart
Aug page 69 LAR-14142

TANKS (CONTAINERS)
Estimating liquid and gas contents in a tank
May page 51 MSC-21500

SUBMILLIMETER WAVES
Quasi-optical millimeter-wavelength resonator
Jun page 16 NPO-17919

Dual-diaphragm tank with leakage-indicating drain
Sep page 91 MSC-21703

Making high-pass filters for submillimeter waves
Aug page 83 NPO-17992

SWIRLING
Low-leakage inlet swirl brake
Oct page 74 MFS-29608

TAPS
Hand broaching tool for use in confined areas
Jun page 123 MFS-29669

SUBSONIC WIND TUNNELS
Experiments on schemes for adaptive-wall wind tunnels
Dec page 72 ARC-12116

Improved gas-gap heat switch
Aug page 49 NPO-18136

TEACHING MACHINES
Intelligent computerized training system
Oct page 107 MSC-21381

SUBSTRATES
Lightweight substrates for mirrors
Jan page 32 NPO-17854

Valve- and switch-monitoring computer program
Nov page 98 MSC-21720

Preventing vapor deposition on the backs of substrates
Jan page 44 LAR-14071

SWITCHING CIRCUITS
Driver circuit for high-power MOSFET's
Nov page 28 LEW-15089

TELECOMMUNICATION
Multistage estimation of frequency and phase
Jan page 27 NPO-17911

SUNLIGHT
Variable-vision sun visor
Jul page 44 LAR-14147

Burst-compression and expansion for TDMA communication
Jun page 40 LEW-15102

SUPERCONDUCTORS
Forming $YBa_2Cu_3O_x$ superconductors on copper substrates
Mar page 38 KSC-11448

Transmitting reference radio signal on two optical carriers
Jun page 32 NPO-18007

Passivation of high-temperature superconductors
Apr page 69 NPO-17949

Stereoscopic configurations to minimize distortions
Oct page 34 NPO-18028

Performance of superconducting-cavity maser
Jun page 30 NPO-18175

Estimating rain attenuation in satellite computation links
Dec page 48 LEW-14979

SUPersonic COMBUSTION RAMJET ENGINES
Simulating the performance of a scramjet
Mar page 42 ARC-12338

Estimating SAR Doppler shifts from homogeneous targets
Oct page 102 NPO-17869

SUPersonic WIND TUNNELS
Experiments on schemes for adaptive-wall wind tunnels
Dec page 72 ARC-12116

Improved radiometric correction for SAR images
Oct page 37 NPO-17931

TELEMETRY
Behavior of Costas loop in reception of telemetry
Aug page 30 NPO-18084

SUPPORTS
Lightweight composite core for curved composite mirrors
Jun page 116 NPO-17858

Ambiguity of Doppler centroid in synthetic-aperture radar
Nov page 48 NPO-17943

System decomposes and displays telemetry data
Sep page 89 GSC-13324

SURFACE CRACKS
Penetrant-indication-measuring compass
Jun page 110 MFS-29643

Program Processes SAR data
Dec page 52 NPO-18048

TELEOPERATORS
Active compliance and damping in telemannipulator control
Apr page 48 NPO-17969

SURFACE FINISHING
Smother turbine blades resist thermal shock better
Jul page 81 MFS-28472

Experiences with the JPL telerobot testbed
Aug page 30 NPO-17928

h-Parameter analysis of teleoperators
Jun page 97 NPO-17527

Pressure roller for tape-lift tests
Sep page 105 GSC-13230

Anthropomorphic robot hand and teaching glove
Sep page 99 GSC-13244

Expert script generator
Oct page 70 LAR-14065

Polyamide-imides made from BTDA
May page 48 LAR-13942

Hidden-Markov-model analysis of telemannipulator data
Oct page 87 NPO-18000

Software for integration of EVA and telerobotics
Oct page 69 NPO-18220

1991 Annual Subject Index

Software for supervisory and shared control of a robot Oct page 102 NPO-18116	TEST PATTERN GENERATORS Waveform-generating program Sep page 87 MFS-28408	THERMOSTATS Improved gas-gap heat switch Aug page 49 NPO-17928	Hand broaching tool for use in confined areas Jun page 123 MFS-29669
Testbed for telerobotic servicing Oct page 32 NPO-18061	TESTERS Addressable-matrix integrated-circuit test structure Nov page 32 NPO-18162	THICKNESS Gauge measures thicknesses of blankets Mar page 47 MSC-21693	Tool removes coil-spring thread inserts Jun page 106 MFS-28432
TELESCOPES System would keep telescope reflector segments aligned Apr page 40 NPO-17903	THERMAL ANALYSIS Integrated analysis capability program Dec page 54 GSC-13341	THIN FILMS Testing conductive films for continuity Feb page 41 NPO-17938	Staking pliers Sep page 104 MSC-21725
Aiming schedule for orbiting astrometric telescope Aug page 57 ARC-12103	Thermal Conductors Thermal strap and cushion for thermoelectric cooler Jun page 16 NPO-17806	Electrochemical deposition of conductive polymers Apr page 64 NPO-17826	Compact gas/tungsten-arc welding torch Jun page 108 MFS-29668
Digital control of a telescope in an airplane Aug page 29 ARC-12399	Thermal insulation Low-thermal-conduction links for silicon sensors Feb page 38 GSC-13321	Push tester for laminated films Sep page 92 NPO-18063	Plasma-arc torch for welding ducts in place Jun page 118 MFS-29701
Modification of catadioptric telescope for laser velocimetry Aug page 56 ARC-12610	Gauge measures thicknesses of blankets Mar page 47 MSC-21693	Deposition of diamondlike films by ECR microwave plasma Oct page 42 NPO-18094	Smaller coaxial-view welding torch Dec page 82 MFS-29744
TEMPERATURE CONTROL Higher-performance ambient-temperature heat pipe May page 57 MSC-21515	Tests of flexible multilayer insulations Jul page 58 ARC-12405	Diamond-coated wire-feeding nozzle Nov page 93 MFS-29714	TOROIDS Spacing windings evenly in toroidal inductors May page 69 NPO-17830
Vapor-resistant heat-pipe artery Jun page 61 MSC-21492	THERMAL RADIATION Script-factor modeling of absorption in a solar receiver Dec page 40 NPO-18018	THREADS Tool removes coil-spring thread inserts Jun page 106 MFS-28432	TORQUE CONVERTERS Torque-splitting gear drive Apr page 90 LEW-14908
Transpiration cooling of hypersonic blunt body Aug page 57 ARC-12383	THERMAL SHOCK Smoother turbine blades resist thermal shock better Jul page 81 MFS-28422	THREE DIMENSIONAL BODIES Software for depiction of three-dimensional objects Dec page 55 MSC-21708	TORQUEMETERS Noncontact measurements of torques in shafts Mar page 50 MFS-29717
TEMPERATURE DISTRIBUTION Computing temperatures in optically pumped laser rods Jul page 63 LAR-14209	Thermal stresses Temperature, thermal stress, and creep in a structure Nov page 81 ARC-12213	THREE DIMENSIONAL FLOW Holographic interferometry to measure three-dimensional flow Jun page 60 ARC-11474	IMPROVED FORCE-AND-TORQUE SENSOR ASSEMBLY Sep page 95 NPO-17370
TEMPERATURE MEASUREMENT Nonintrusive measurement of temperature of LED junction Mar page 33 GSC-13339	THERMISTORS Computed tomography for inspection of thermistors Jun page 111 MFS-29662	TORQUERS Serves reduces friction in flexure bearing Nov page 74 LAR-14349	TORSION Investigation of tapered tension/torsion strap Dec page 68 ARC-12480
Laser spectroscopic measurement of temperature and density May page 43 ARC-12719	THERMOCOUPLES Thermocouple-signal-conditioning circuit Jul page 20 MFS-29695	ADAPTIVE GRIDS FOR COMPUTATIONS OF THREE-DIMENSIONAL FLOWS Aug page 66 ARC-12479	TRAINING DEVICES Intelligent computerized training system Oct page 107 MSC-21381
Integral plug-type heat-flux gauge Aug page 72 LEW-14967	Thermoelectric cooling Thermal strap and cushion for thermoelectric cooler Jun page 16 NPO-17806	TILES Detecting filler spaces under tiles May page 61 KSC-11411	TRAJECTORIES Plotting orbital trajectories for maneuvers Oct page 68 ARC-12365
TEMPERATURE SENSORS Sensing temperatures via prostheses and manipulators Oct page 35 MSC-21676	Thermoelectric power generation TEM pump with external heat source and sink Jul page 79 NPO-17864	TILT ROTOR AIRCRAFT Frequency-domain identification of aeroelastic modes Dec page 73 ARC-12407	TRANSFER FUNCTIONS Transfer functions via Laplace- and Fourier-Borel transforms Sep page 112 ARC-12295
TEMPERING Gradient tempering of bearing races Sep page 107 MFS-28496	Heat-transfer coupling for heat pipes Sep page 92 NPO-17863	TIME DIVISION MULTIPLE ACCESS Burst-compression and expansion for TDMA communication Jun page 40 LEW-15102	TRANSFORMATIONS (MATHEMATICS) Transformations for atmospheric-radiation calculations Jul page 42 NPO-18026
TENSILE TESTS Layered plating specimens for mechanical tests Nov page 94 MFS-29718	Calculating thermophysical properties of 12 fluids Dec page 52 MSC-21664	TIME SIGNALS Diplex fiber-optic link for frequency and time signals Jun page 39 NPO-18180	TRANSIENT RESPONSE Calculating transient vibrations of coupled substructures May page 54 MFS-28477
TEST EQUIPMENT Experiences with the JPL telerobot testbed Aug page 30 NPO-17928	Thermophysical properties Thermally actuated unlatching mechanism May page 57 NPO-17601	TOOLING Flexible generation of array-detector timing signals Oct page 35 GSC-13345	TRANSISTORS Doping to reduce base resistances of bipolar transistors May page 22 NPO-17948
Push tester for laminated films Sep page 92 NPO-18063	TOOLING Verification of tooling for robotic welding Aug page 85 MFS-29725	TOOMOGRAPHY Computed tomography for inspection of thermistors Jun page 111 MFS-29662	ALTERNATIVE ALGa_xAs/GaAs TRANSISTORS FOR NEURAL NETWORKS Alternative AlGa _x As/GaAs transistors for neural networks Sep page 26 NPO-18177
Testbed for telerobotic servicing Oct page 32 NPO-18061	TOOLS Alignment tool for inertia welding Mar page 59 MFS-29667	TOOLING Bar-code-scribing tool Mar page 58 MFS-28441	HIGH-GAIN ALGa_xAs/GaAs TRANSISTORS FOR NEURAL NETWORKS High-gain AlGa _x As/GaAs transistors for neural networks Sep page 24 NPO-18101
Magnetic-bearing test fixture Nov page 82 LAR-14312	New polyimide has many uses Sep page 85 LAR-14163	TRANSMISSIONS (MACHINE ELEMENTS) Computing lives and reliabilities of turboprop transmissions Mar page 44 LEW-14905	COSPONSORED BY HEWLETT-PACKARD, TRANSERA, AND TSA.
Dynamic tester for rotor seals and bearings Dec page 80 MFS-28493			
TEST FACILITIES Facility measures magnetic fields Sep page 65 NPO-18187			
NASA Tech Briefs, January 1992			

RMB STRATEGY FOR THE '90s

A Conference for Rocky Mountain BASIC Users

- COMPUTER AIDED TEST
- DATA ACQUISITION
- INSTRUMENT CONTROL
- GRAPHICS
- DATABASES
- 3D SOLID MODELING
- RENDERING

The Most Important Event of the Decade for HP BASIC Users.

"HP and TransEra have revitalized the RMB market for the '90s. This conference is a must for anyone who uses RMB."

—Jim Bailey, conference organizer and noted RMB columnist.

Organized by the International User Association.

March 18-20, 1992
Long Beach, Calif.

CALL:
I-800-488-7560

Cosponsored by Hewlett-Packard, TransEra, and TSA.

NEW Pump heads!

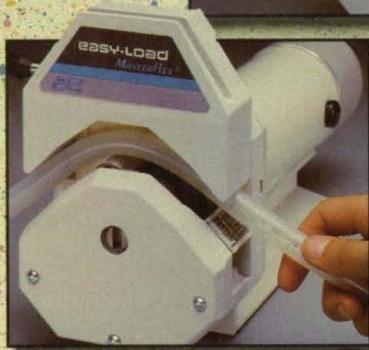
Masterflex® I/P easy-load™

as
easy
as...

1
OPEN



2
INSERT
TUBING



3
CLOSE
AND
START
PUMPING



IT'S
easy!

For fast and easy tubing changes, your choice is EASY. Easy-Load™ pump heads open and close with the flip of a lever. Simply turn a knob to adjust tubing occlusion. Masterflex® I/P Easy-Load pump heads mount directly to Masterflex I/P drives, accept the same tubing, and produce the same flow rates (up to 13 liters/min) as your current Masterflex I/P pump heads. You can stack several Easy-Load pump heads on a single drive and change the tubing in one Easy-Load without interrupting other pump heads. Add Easy-Load to your Masterflex peristaltic system today. Your choice is EASY!

Easy-Load™ - TM Cole-Parmer Instrument Co.
Masterflex® - Reg TM Cole-Parmer Instrument Co.

**Cole-Parmer®
Instrument Company**
7425 N. Oak Park Ave., Chicago, IL 60648
DIAL: 1-800-323-4340 or
1-708-647-7600
FAX: 1-708-647-9660

Circle Reader Action No. 638

TRANSMITTER RECEIVERS

Quad-port transceivers for a dual-CRR LAN
Feb page 28 NPO-17541

TRANSONIC FLOW

Transonic aerelasticity analysis for helicopter rotor blade
Jun page 60 ARC-12550

Navier-Stokes simulation of wind-tunnel flow
Oct page 85 ARC-12193

Transonic flows about a fighter airplane
Oct page 79 ARC-12304

Navier-Stokes computations on zonal grids
Dec page 71 ARC-12447

TRANSPIRATION

Transpiration cooling of hypersonic blunt body
Aug page 57 ARC-12383

TRANSPORT THEORY

Computation of facilitated transport of O₂ in hemoglobin
Jun page 128 ARC-12417

TRAPPED PARTICLES

Trapped-mercury-ion frequency standard
Jun page 55 NPO-17456

TRENDS

Estimating confidence in data via trend analysis
Mar page 63 MFS-29710

TRIBOLOGY

Ion processes modify tribological properties of surfaces
Apr page 96 LEW-14865

TRUSSES

Quick-connect truss fastener
Jul page 84 MSC-21504

Quick-connect/disconnect joint for truss structures
Sep page 102 MSC-21539

Dynamic analyses including joints of truss structures
Dec page 62 LAR-14306

Two techniques for suppressing vibrations in structures
Dec page 60 NPO-17889

TUBE HEAT EXCHANGERS

Two-phase bidirectional heat exchanger
Mar page 49 GSC-13287

TUNABLE LASERS

Computer processing of tunable-diode-laser spectra
May page 28 NPO-18019

Acousto-optical filter can rapidly tune solid-state lasers
Jun page 52 NPO-17891

Stirling-cycle cooling for tunable diode laser
Aug page 16 NPO-18045

TURBINE BLADES

Smoother turbine blades resist thermal shock better
Jul page 81 MFS-28472

TURBINE ENGINES

Computing rotational/vibrational dynamics of turbine engines
Mar page 42 LEW-14770

TURBINE PUMPS

Model of bearing with hydrostatic damper
Jan page 43 MFS-29654

Laser welding of contoured thin-wall housings
Mar page 57 MFS-29653

Computing flow in a labyrinth seal
Jun page 98 MFS-29682

Damping seals would help support turbopump rotor
Aug page 77 MFS-27227

Dynamic tester for rotor seals and bearings
Dec page 80 MFS-28493

TURBINES

Simulation of flow in a turbine cascade
Feb page 58 ARC-12551

Computation of flow in a turbine stage on a refined grid
Nov page 90 ARC-12444

TRANSPORT

Two-phase Hero turbine with curved nozzles
Nov page 87 NPO-18059

TURBOMACHINERY

Using multiple grids to compute flows
Mar page 37 ARC-12321

TRENDS

Low-leakage inlet swirl brake
Oct page 74 MFS-29608

TURBOPROP ENGINES

Computing lives and reliabilities of turboprop transmissions
Mar page 44 LEW-14905

TURBOSHAFTS

Computer simulation of a small turboshaft engine
Mar page 55 ARC-12299

TURBULENCE

Analysis of turbulence in a simple shear flow
Apr page 84 NPO-17374

TURBULENT FLOW

Mathematical models of turbulence in hypersonic flow
Dec page 67 ARC-12609

TURBULENT MIXING

Computed turbulent flow in a turnaround duct
Oct page 82 ARC-12552

TUNABLE LASERS

Pressure fluctuations in simulated turbulent channel flow
Oct page 80 ARC-12597

VALVES

Reed valve regulates welding back-purge pressure
Jul page 81 MFS-29684

VACUUM

Long-lived, replaceable low-pressure seals
Sep page 98 MFS-28521

VACUUM CHAMBERS

Penetrable linear-gap pressure seal
Jul page 70 LEW-14965

VACUUM DEPOSITION

Deposition of diamondlike films by ECR microwave plasma
Oct page 42 NPO-18094

VALVE

Heavy-workplace handler for vacuum plasma spraying
Oct page 99 MFS-28522

VALVES

Reed valve regulates welding back-purge pressure
Jul page 81 MFS-29684

VANE

Rotary-to-axial motion converter for valve
Oct page 76 MSC-21697/8

VANE

Pressure-actuated flow-control valve
Nov page 74 MFS-28513

VANE

Valve- and switch-monitoring computer program
Nov page 98 MSC-21720

VANE

Lightweight valve closes duct quickly
Dec page 64 MFS-28511

VANE

Lock for valve stem
Dec page 63 MFS-29764

VANE

Composite-material airflow vane
Sep page 108 LAR-14192

U

ULTRASONIC WAVE TRANSDUCERS

Improved ultrasonic transducer for measuring cryogenic flow
Nov page 78 MFS-29687

ULTRASONICS

Ultrasonic device monitors fullness of the bladder
Sep page 115 LAR-13689

Ultrasonic device would open pipe bombs
Sep page 108 NPO-17951

ULTRAVIOLET DETECTORS

GaAsP photodiodes as x-ray detectors
Sep page 22 NPO-17849

ULTRAVIOLET RADIATION
Broadband, achromatic Twyman-Green interferometer
Oct page 38 NPO-17675

UREAS

Treating wastewater with immobilized enzymes
Feb page 70 MFS-26090

URETHANES

Reactive fluorescent dyes for urethane coatings
Oct page 44 NPO-18038

USER REQUIREMENTS
YAMM—yet another menu manager
Feb page 47 NPO-17769

V

VACUUM

Long-lived, replaceable low-pressure seals
Sep page 98 MFS-28521

VACUUM CHAMBERS

Penetrable linear-gap pressure seal
Jul page 70 LEW-14965

VACUUM DEPOSITION

Deposition of diamondlike films by ECR microwave plasma
Oct page 42 NPO-18094

VALVE

Heavy-workplace handler for vacuum plasma spraying
Oct page 99 MFS-28522

VALVE

Reed valve regulates welding back-purge pressure
Jul page 81 MFS-29684

VALVE

Rotary-to-axial motion converter for valve
Oct page 76 MSC-21697/8

VALVE

Pressure-actuated flow-control valve
Nov page 74 MFS-28513

VALVE

Valve- and switch-monitoring computer program
Nov page 98 MSC-21720

VALVE

Lightweight valve closes duct quickly
Dec page 64 MFS-28511

VALVE

Lock for valve stem
Dec page 63 MFS-29764

VALVE

Composite-material airflow vane
Sep page 108 LAR-14192

1991 Annual Subject Index

VAPOR DEPOSITION

Preventing vapor deposition on the backs of substrates
Jan page 44 LAR-14071

Fabrication of lightweight mirrors via CVD
Jun page 122 LAR-14299

Preventing chemical-vapor deposition in selected areas
Jun page 122 LAR-14300

VAPORS

Calculating thermophysical properties of 12 fluids
Dec page 52 MSC-21664

VARIATIONAL PRINCIPLES

Norms and completeness in variational methods
May page 71 NPO-18071

VAX COMPUTERS

Graphics software for VT terminals
Jul page 64 MFS-27214

VECTORS (MATHEMATICS)

Optical computation of matrices from vectors
Jan page 56 NPO-17512

Optical computation of matrices from vectors
Feb page 70 NPO-17512

VELOCITY MEASUREMENT

Digital image velocimetry
Oct page 78 ARC-12774

Digital image velocimetry
Nov page 96 ARC-12474

VERY LARGE SCALE INTEGRATION

Neural networks of VLSI components
Feb page 24 NPO-17833

Modular VLSI Reed-Solomon decoder
Sep page 49 NPO-17897

VERY LONG BASE INTERFEROMETRY

Estimating baselines from constrained data on GPS orbits
Nov page 40 NPO-18173

VIBRATION

Analyzing control/structure interactions
Oct page 67 LEW-14904

Algorithm reveals sinusoidal component of noisy signal
Dec page 86 MFS-29688

VIBRATION DAMPING

Experiments in adaptive control of a flexible structure
Feb page 31 NPO-17846

Composite struts would damp vibrations
Apr page 79 NPO-17914

Improved notch filter for synchronous-response control
Apr page 48 LAR-14173

Damping of vibrations in graphite/epoxy structures
Jul page 74 MFS-27228

Adaptive control of large vibrating, rotating structures
Sep page 90 NPO-17471

Two techniques for suppressing vibrations in structures
Dec page 60 NPO-17889

VIBRATION EFFECTS

Computing rotational/vibrational dynamics of turbine engines
Mar page 42 LEW-14770

VIBRATION MEASUREMENT

Monitoring bearing vibrations for signs of damage
Dec page 78 MFS-29734

Monitoring engine vibrations for spectrum of exhaust
Dec page 79 MFS-29733

VIBRATION MODE

Block Lanczos algorithm for gyroscopic systems
Aug page 75 ARC-12147

VIBRATION TESTS

Low-frequency suspension system for large space structures
Jun page 62 LAR-14149

VIDEO DATA

Displaying images of planets
Jun page 57 NPO-17977

Video recording of images in laser remote sensing
Jul page 26 GSC-13398

Video image communication and retrieval—updated
Nov page 66 NPO-18076

VIDEO EQUIPMENT

Stereoscopic video weld-seam tracker
Mar page 29 MFS-26116

Half-tone video images of drifting sinusoidal gratings
Apr page 46 ARC-12414

Beam splitter for welding-torch vision system
May page 67 MFS-29641

Effects of frame rates in video displays
Aug page 32 ARC-12358

More about video-feedback docking system
Oct page 36 MFS-28419

VIDEO SIGNALS

Video pipeline tree for scan conversion of triangles
Aug page 27 ARC-11661

VINYL POLYMERS

Reactions of atomic oxygen [$O(^3)P$] with polybutadienes
Apr page 72 ARC-11851

VISSOUS DRAG

Polymers and riblets reduce hydrodynamic skin friction
Oct page 77 LAR-14271

VISSOUS FLOW

Calculating viscous/inviscid interactions
Apr page 85 ARC-12115

Computational fluid dynamics in aerospace
Apr page 86 ARC-12107

Accounting for compressibility in viscous flow in pipes
Aug page 66 ARC-12249

Incompressible, viscous flow about an ogive/cylinder
Aug page 73 ARC-11793

Computations of impulsively started viscous flow
Dec page 75 ARC-12382

Computed hypersonic viscous flows over delta wings
Dec page 70 ARC-12179

Methods of simulation of incompressible flow
Dec page 74 ARC-12199

VISIBLE INFRARED SPIN SCAN RADIOMETER

Airborne calibration of an orbiting radiometer
Jun page 48 ARC-12617

VISORS

Protecting helmets and visors from chemicals
Apr page 70 MSC-21503

VISTOL AIRCRAFT

Research on controls and displays for VISTOL airplanes
Sep page 68 ARC-12215

VISUAL AIDS

Program generates images of solid surfaces
Jan page 38 MSC-21630/49

VISUAL PERCEPTRON

Processing of visual information in primate brains
Mar page 67 NPO-17900

VOIDS

Radiographic detection of voids in SiC and SiN ceramics
Jan page 34 LEW-14881

VOLTAGE CONVERTERS (DC TO DC)

Switched-capacitor voltage multiplier
Aug page 16 NPO-17994

VUGLEGUIDE ANTENNAS

Megawatt square microwave feed horn
Jun page 22 NPO-18025

WAXES

Hot oil removes wax
Feb page 60 MFS-29713

WEAVING

Farley three-dimensional-braiding machine
Mar page 60 LAR-13911

WEIGHTLESSNESS

More life-science experiments for Spacelab
Apr page 102 ARC-12316

WEIGHTLESS SIMULATION

Zero-spring-rate mechanism/air suspension cart
Aug page 69 LAR-14142

WELD TESTS

Flexible interior-impression-molding tray
May page 63 MFS-29679

WELDED JOINTS

Monitoring weld penetration via gas pressure
May page 64 MFS-29683

WELDING

Eliminating unbonded edges in explosive bonding
Jan page 45 LAR-14096

Alignment tool for inertia welding
Mar page 59 MFS-29667

WAFERS

Rapid dry etching of photoreists without toxic gases
Jun page 104 ARC-11873

WASHERS (CLEANERS)

Dishwasher for Earth or outer space
Jul page 78 MSC-21442

WASHERS (SPACERS)

Lockwasher strongly resists disassembly
Nov page 93 MFS-29696

WASHING

Portable water-saving shower for emergencies
Oct page 115 MFS-28459

WASTE ENERGY UTILIZATION

Nonazeotropic heat pump
Mar page 51 MFS-26099

WASTE WATER

Treating wastewater with immobilized enzymes
Feb page 70 MFS-26090

WATER HEATING

Nonazeotropic heat pump
Mar page 51 MFS-26099

WATER TREATMENT

Treating wastewater with immobilized enzymes
Feb page 70 MFS-26090

WATER VEHICLES

Reducing water/hull drag by injecting air into grooves
Dec page 59 LAR-14078

WAVE SCATTERING

Effects of interference on scattering by parallel fibers
Nov page 60 ARC-12530

WAVEFORMS

Waveform-generating program
Sep page 87 MFS-28408

WAVEGUIDE ANTENNAS

Megawatt square microwave feed horn
Jun page 22 NPO-18025

WAXES

Hot oil removes wax
Feb page 60 MFS-29713

WEAVING

Farley three-dimensional-braiding machine
Mar page 60 LAR-13911

WEIGHTLESSNESS

More life-science experiments for Spacelab
Apr page 102 ARC-12316

WEIGHTLESS SIMULATION

Zero-spring-rate mechanism/air suspension cart
Aug page 69 LAR-14142

WELD TESTS

Flexible interior-impression-molding tray
May page 63 MFS-29679

WELDED JOINTS

Monitoring weld penetration via gas pressure
May page 64 MFS-29683

WELDING

Eliminating unbonded edges in explosive bonding
Jan page 45 LAR-14096

WIND ENERGY UTILIZATION

Nonazeotropic heat pump
Mar page 51 MFS-26099

WIND TUNNEL MODELS

Electro-optical position-measuring system
Jan page 26 LAR-13840

WIND TUNNELS

Twin-mirrored-galvanometer laser-light-sheet generator
May page 30 LAR-14248

WIND TUNNEL WALLS

Experiments on schemes for adaptive-wall wind tunnels
Dec page 72 ARC-12116

WIND VELOCITY MEASUREMENT

Radar backscatter from the ocean at low windspeeds
Sep page 79 NPO-18036

WINDS

Making large suction panels for laminar-flow control
Feb page 61 LAR-13844

WINDING

Spacing windings evenly in toroidal inductors
May page 69 NPO-17830

WING PLANFORMS

Crescent wing planforms reduce lift-dependent drag
Apr page 79 LAR-14015

WINGS

Making large suction panels for laminar-flow control
Feb page 61 LAR-13844

WIRE

Diamond-coated wire-feeding nozzle
Nov page 93 MFS-29714

WORKLOADS (PSYCHO-PHYSIOLOGY)

Human error in complex systems
Apr page 101 ARC-12424

X

X RAY IMAGERY

Imaging microscope for "water-window" x rays
Jul page 40 MFS-28485

Microscope would image x and v rays
Sep page 71 MFS-28484

X RAY INSPECTION

Verifying x-radiographs with computed tomographs
Jun page 116 MFS-29649

X RAY SPECTROSCOPY

GaAsP photodiodes as x-ray detectors
Sep page 22 NPO-17849

X RAY TELESCOPES

Telescope would image x and v rays
Sep page 70 MFS-28482

X RAYS

Compact x-ray and extreme-ultraviolet monochromator
Jun page 44 MFS-28499

Four-mirror x-ray and extreme-ultraviolet monochromator
Jun page 44 MFS-28498

Scanning x-ray or extreme-ultraviolet monochromator
Aug page 52 MFS-28492

Ultra-high-spectral-resolution x-ray/EUV monochromator
Sep page 70 MFS-28500

X-15 AIRCRAFT

Frequency-domain identification of aeroelastic modes
Dec page 73 ARC-12407

Y

YARNS

Silicon carbide threads for high-temperature service
Apr page 64 ARC-12406

Z

ZEOLITES

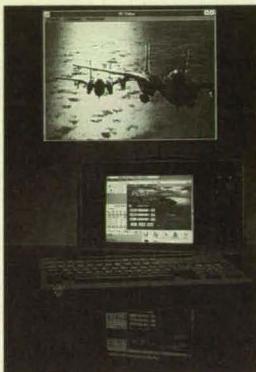
Zeolites remove sulfur from fuels
Apr page 68 NPO-17480

Copper-exchanged zeolite L traps oxygen
Sep page 86 NPO-17761

ZIRCONIUM OXIDES

Fabrication of ceramic mats
Apr page 94 NPO-17210

New on the Market

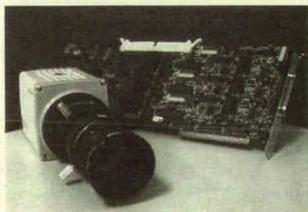


Dolch Computer Systems, Milpitas, CA, has announced the industry's first implementation of **full-motion video on a TFT color flat-panel display**, enabling multimedia computing on any of Dolch's PAC 386® and PAC 486® portable platforms. Video input can be from any NTSC-, PAL-, or SECAM-compatible analog source. Presented within the Multimedia Extensions of Microsoft Windows™, the image can be scaled and positioned at will, and shown with any number of freeze-frame video windows.

Circle Reader Action Number 774.

HyComp 400, a high-temperature **epoxy resin** developed by Dexter Composites Inc., Cleveland, OH, has a glass transition temperature of 256° C and retains 70 percent of its room temperature properties at 232° C. Processing ease, resistance to hot/wet conditions, and relatively low viscosity make it suitable for industrial and aerospace applications in primary and secondary composite structures.

Circle Reader Action Number 798.



An innovative **image acquisition system** developed by i Sight Inc., Orangeburg, NY, achieves a wider dynamic range than existing electronic imaging technology. By emulating the biological processing performed by the human eye and brain, the system enables conventional electronic cameras to capture high-contrast scenes without compromising image quality, resolution, or signal-to-noise ratio. This technique, called Adaptive Sensitivity™, expands the camera's dynamic range to about 100 dB or 100,000:1.

Circle Reader Action Number 776.

FLIR Systems, Portland, OR, has introduced the IQ 325 **thermal imager** for detecting, measuring, analyzing, processing, and displaying infrared radiation. It provides the industry's highest-resolution, thermal real-time image, according to the manufacturer, for use in process control, preventative maintenance, microelectronics, and R&D. The system's hard disk drive permits storage, retrieval, and analysis of more than 500 images.

Circle Reader Action Number 800.

The FAX Vodem™ from Yamaha Systems Technology Div., San Jose, CA, provides **multimedia capabilities on a single chip**, enabling the transmission of graphics, data, and voice messages over a single line. Caller identification is also available. The chip uses 0.8 micron technology and Sigma-delta modulation techniques. A CMOS device, it requires only 300 milliwatts in active mode from a 5V power supply.

Circle Reader Action Number 788.



The 900 series of **machine vision systems** from Acumen Inc., Corvallis, OR, can determine the position, orientation, and scale of arbitrary gray-scale image patterns. Fully configured, they can perform gray-scale normalized correlation at a throughput rate of 3.4 billion operations per second. The systems provide sub-pixel accuracy for solving problems in alignment, inspection, measurement, optical character recognition and verification, robot guidance, and color image acquisition.

Circle Reader Action Number 784.

An advance in **diamond film production** has been announced by Applied Science and Technology Inc., Woburn, MA. The invention, called the Large-Area Diamond System (LADS), is the first plasma source to grow eight-inch-diameter films with 25 percent uniformity and coat complex shapes. Powered by a 5000-watt microwave generator, with the plasma torch operating in a resistively-heated furnace, LADS achieves high temperature stability to yield films with low stress.

Circle Reader Action Number 780.

John Fluke Mfg. Co., Everett, WA, has introduced Philips PM 9372 TeleGnostics software, which enables troubleshooting and repair of complex electronic equipment using digital storage oscilloscopes (DSOs) supported by telephone lines. The package provides a phone link between a remote DSO and a PC located at a central service center. Diagnosticians at the center can monitor and analyze captured waveforms and relay instructions to the on-site technicians.

Circle Reader Action Number 794.



Land Infrared, Bristol, PA, has introduced a line of **infrared linescan systems** for temperature measurement from 300° to 1200° C. The Landscan linescanners provide accurate, noncontact temperature measurement across an object's entire surface. Software features include acquisition of up to 1000 temperature samples per scan at 25 scans per second and real-time image transfer and display as a 16-color thermal map.

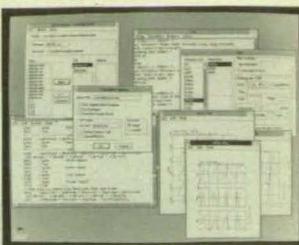
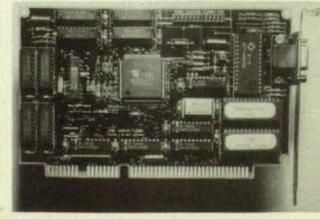
Circle Reader Action Number 782.

Philips Semiconductors, Slatersville, RI, has created the industry's first monolithic, fully-protected **MOSFET**. Called TOPFET® (Temperature and Overload Protected Field Effect Transistor), it provides temperature and short circuit protection using N-channel enhancement-mode DMOS technology. TOPFET offers temperature protection for T_{case} above 150° C, rugged overvoltage clamping for inductive load repetitive switching, and input ESD protection. Characteristics include immunity to high dv/dt and a low operating input current.

Circle Reader Action Number 778.

The industry's fastest 16-bit, 1 MB **VGA adapter card** is available from Bell Computer Systems, Van Nuys, CA. The new 32,000 Freedom Hi-Color tested at 10,150 characters per millisecond on Landmark 2.0. The ISA-bus-compatible card delivers 32,000 colors at 640 x 480 and 800 x 600 resolutions, and 256 colors at 1024 x 768 resolution.

Circle Reader Action Number 796.



ACSL/Windows, the first **Windows-based, nonlinear simulation environment** for the PC, has been announced by Mitchell & Gauthier Associates Inc., Concord, MA. Employing a menu-driven point-and-click format, the program allows users to produce simulation models with no size limits. Models developed on a PC can be moved to any other platform and vice versa.

Circle Reader Action Number 790.

NEEL Electronics Inc., Laguna Niguel, CA, has announced the DSA100, a single-board, multiple-channel **digital synthesizer and analog analyzer**. Two independently-programmable synthesizers provide flexibility in waveform generation and can be phase-locked, while the analog analyzer enables wide-frequency analyses in frequency domain. Both heterodyne and homodyne analyses are possible for frequencies up to 100 kHz.

Circle Reader Action Number 782.

A line of flexible **temperature sensors** that conform to curved, cylindrical, and conical surfaces has been introduced by Elmwood Sensors Inc., Pawtucket, RI. Their ability to sense the temperature of an entire surface area and their thin, lightweight construction ensure fast, reliable response to surface temperature changes, according to the manufacturer. Applications include motor protection, air and liquid level sensing, laboratory instruments, and laminating equipment.

Circle Reader Action Number 772.



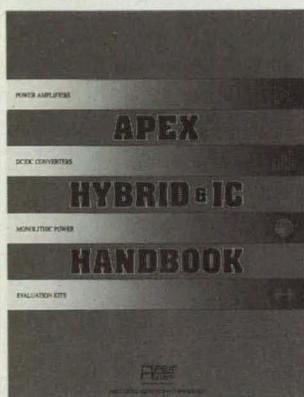
A new **CAD/CAM system** from TekSoft Inc., Phoenix, AZ, runs the entire CNC manufacturing process from a PC. Drafting, design, prototyping, and tool path generation programs can be created for mill, lathe, punch, laser, plasma, and wire EDM machines. Users also can work on part geometries imported from other systems through IGES, DXF, or VDA translators.

Circle Reader Action Number 792.

New Literature

The new product handbook from Apex Microtechnology Corp., Tucson, AZ, spotlights the company's power and high-voltage operational amplifiers. This 264-page guide features the new DB2800 series of DC/DC converters and the PA41, the first 350 V monolithic op amp. Also included are application notes discussing MOSFETs, wideband, low-distortion techniques, and DC/DC converter performance enhancements.

Circle Reader Action Number 710.



Bearings and Gears 1991, a comprehensive report covering the development, analysis, and manufacture of materials for bearings, gears, and other machine elements, is offered by ASM International, Materials Park, OH. Derived from international databases and 800 corporate case studies, the report details the design, fabrication, and selection of materials, lubricants, and components for mechanical systems in commercial and industrial applications. Materials covered include steels, ferrous and nonferrous metals and alloys, intermetallics, engineered plastics, polymers, and composites.

Circle Reader Action Number 706.

Premium cutting, grinding, mounting, and polishing supplies for materials preparation are described in a full-color catalog from Excel Technologies Inc., Enfield, CT. The 24-page brochure is also available on 3 1/2" or 5 1/4" disk.

Circle Reader Action Number 704.

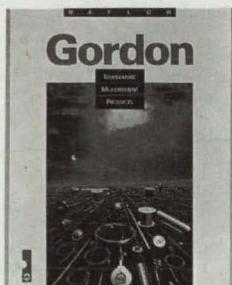


How to Select Pressure Transducers, a 16-page handbook from Trans Metrics Inc., Solon, OH, covers pressure ranges, accuracy, output signals, circuitry, electrical connections, transducer interchangeability, and application environments. It provides a worksheet to aid engineers in transducer specification.

Circle Reader Action Number 712.

A 24-page catalog describes two-wire and four-wire temperature transmitters from S-Products Inc., Fairfield, CT. The full-color publication features an ultraminiature two-wire RTD transmitter that provides ±0.5 percent accuracy, as well as two-wire fully-isolated head-mount transmitters, fully-linearized head-mount thermocouple transmitters, and scaleable four-wire rail- or wall-mount transmitters.

Circle Reader Action Number 708.



Watlow Gordon, St. Louis, MO, has released a 365-page catalog of temperature measurement products including several hundred styles of sensors, controls, wire, and accessories. New products include three types of infrared sensors and a noise-suppressed interconnect cable. The publication also features a 65-page technical guide addressing thermocouple practice, troubleshooting, calibration techniques, and standards.

Circle Reader Action Number 702.

An eight-page brochure from the Fidelis Group's Cyborg Div., Newton, MA, describes its line of modular data acquisition and signal conditioning platforms. The systems are supported by LabSoft I and II Programmer's Toolkit and Discovery DAS menu-driven software.

Circle Reader Action Number 714.

STRUCTURAL ADHESIVE RESISTS UP TO 500°F

MASTER BOND POLYMER SYSTEM EP34CA

- Excellent bond strength to similar and dissimilar substrates
- 100% reactive, does not contain solvents or other volatiles
- Low viscosity assures convenient application
- Simplified thermal cure schedules
- Highest physical strength properties
- Outstanding dimensional stability and durability
- Superior resistance to water, fuels, lubricants and other aggressive chemicals
- Remarkable electrical insulation properties
- Job-tailored packaging

For information,
call or write:
Master Bond Inc.,
154 Hobart St.
Hackensack, NJ 07601
201-343-8983

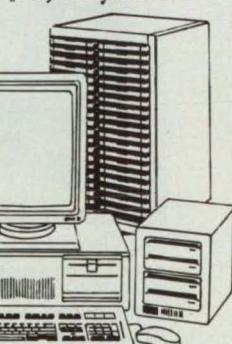
Master Bond Inc.
Adhesives, Sealants & Coatings

Circle Reader Action No. 604

WHEN TIMES ARE TOUGH, WHO WINS RATIONALIZING OR RATIONALITY?

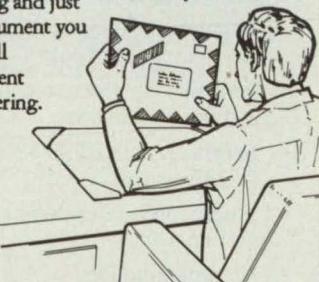
We all know times are tough and budgets are tight. Your job is to keep the company profitable. Why spend \$20,000 or more per year to lease a full text standards and specifications system, of which the vast majority of documents you never even access. For under \$1000 per year you can have a personalized update service that provides you all the documents you need and only what you need. Document Engineering ships orders the same day. You choose the level of service: 1st class mail, Fed Ex or fax.

\$20,000/yr. lease



For personal service, fast shipping and just the document you need call Document Engineering.

\$1,000/yr. service



Document Engineering



15210 Stagg Street
Van Nuys CA 91405
Tel(818)782-1010 Fax(818)782-2374

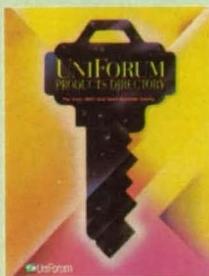
800-DOC-ENGR
800-362-3647

Circle Reader Action No. 312

MARKETPLACE

To Advertise—Call (212) 490-3999

THE ONLY UNIX AND OPEN SYSTEMS SOURCE



Why look anywhere else?

If it's not in the 1992 *UniForum Products Directory*, chances are you won't find it elsewhere. The 1992 Directory features 7,600 products and services from 2,100 vendors. We've got it all. More software. More hardware and peripherals. More developers, consultants, books and head-hunters than available anywhere else. Only \$95.

To order, call 800-255-5620

UniForum 2901 Tasman Dr., #201
Santa Clara, CA 95054
(800) 255-5620 (408) 986-8840 Fax (408) 986-1645

Circle Reader Action No. 595

FREE!

CATALOG of REAL TIME DATA ACQUISITION PRODUCTS for the PC

Filled with applications information, competitive comparisons, waveform analysis techniques, hardware and software specifications, and DEMO DISK!

We manufacture the industry's fastest data acquisition hardware and software designed for applications that demand a true real time display with simultaneous disk streaming. Call us at...

1-800-553-9006

DATAQ INSTRUMENTS, INC
150 Springside Drive, Suite B220
Akron, OH 44333
Tel (216) 668-1444 Fax (216) 666-5434

Circle Reader Action No. 489

Get AutoCAT

for only \$295.00 and save \$200.00 before January 1, 1992!

Don't miss the bus!

Software for IBM™ or compatible computers to Automate Computer Aided Tests.

- Performs lab measurements and production tests.
- Interfaces with IEEE-488, RS232 devices.
- Mouse, pull-down menus, on-line help.
- No programming knowledge required.

NEOS

4415B Enterprise Court, Melbourne, FL 32934
Phone: (407) 259-2090 Fax: (407) 255-0274

Circle Reader Action No. 577

REAL-TIME NETWORK

The SCRAMNet™ Network combines the real-time speed of replicated shared memory with the flexibility of a fiber optic LAN to get microsecond response from multi-vendor computers. It offers distinct advantages in critical simulations. Brochure highlights system's features.



Systech Corp., 4126 Linden Avenue, Dayton, OH 45432-3068 USA.
Phone (513) 252-5601 or 1-800-252-5601.

Circle Reader Action No. 511

Fast Thermal Analysis with Theraflash Instruments.

- Thermal Conductivity
- Thermal Diffusivity
- Specific Heat
- Temperatures from -170° to 2000°C
- Tests ceramics, composites, metals, alloys and plastics

Holometrix

25 Wiggins Avenue
Bedford, MA USA
01730-2323
Voice: (800) 688-6738
FAX: (617) 275-3705

Contract testing services also available.



Circle Reader Action No. 481



Free 130 page product catalog from Rolyn, world's largest supplier of "Off-the-Shelf" optics. 24-hour delivery of simple or compound lenses, filters, prisms, mirrors, beam splitters, reticles, objectives, eyepieces plus thousands of other stock items. Rolyn also supplies custom products and coatings in prototype or production quantities. **ROLYN OPTICS Co.**, 706 Arrowgrand Circle, Covina, CA 91722-2199, (818) 915-5707, FAX (818) 915-1379

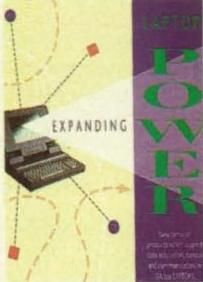
Circle Reader Action No. 551

New Data Acquisition Boards

Contec introduces a new family of data acquisition boards for laptop computers. This line includes digital, analog, and communication hardware and accompanying software for IBM PC XT, AT, 386, and PS/2 computers for factory and laboratory automation.

- 3 year warranty
- 24 hour delivery
- free technical support
- 30 day money-back guarantee

Contec
Microelectronics USA, Inc.
2188 Bering Drive
San Jose, CA 95131
(800) 888-8884
FAX (408) 434-6884



Circle Reader Action No. 688

MAGNET CHARGING/CONDITIONING



Walker Scientific has engineered a full line of magnet charging and conditioning equipment which encompasses DC, half-cycle and capacitive discharge technologies to handle all magnetic materials including the new neodymium-iron-boron (Nd-Fe-B) magnets.

When coupled with Finite-Element-Analysis engineering for fixture design a complete engineered system emerges to provide state-of-the-art performance.

For more information contact:
Walker Scientific Inc./New Jersey Office

Earle Seely, Product Manager
PO Box 294
Mountain Lakes, NJ 07046-0294

Telephone: (201) 402-7862 Fax: (201) 402-7863

Circle Reader Action No. 599

The Best Just Got Better... AND Costs Less

Model R5000 Strip Chart \$1395 up

Features:

- Variable and Fixed Spans
- 17 Chart Speeds
- Integrator Option all in one

to RECORD ALL your needs

Model 4500 Strip Chart \$1095 up

Features:

- 34 Chart Speeds
- Touch Control Panel
- NEW Digital Interface & Remote Control Standard on Every Model

Also inquire about our x-y recorders which replace discontinued Houston Instruments - FISHER SCIENTIFIC - HP Recorders

WE SUPPORT ANY REORDER WITH PARTS-SUPPLIES-SERVICE

THE RECORDER COMPANY
P.O. Box 8 San Marcos, Texas 78667
(512) 629-1400 FAX (512) 353-5333

Circle Reader Action No. 519

MARKETPLACE

To Advertise—Call (212) 490-3999



Reel Moments: A History of Flight and Space

From Kitty Hawk to the Space Shuttle, this exciting videotape chronicles the successes and innovations, the heroes and inventors, in air and space travel. Includes vintage newsreel footage. (VHS, 40 minutes) \$19.95 each plus \$3.00 postage and handling.

Name _____

Address _____

City _____ State _____ Zip _____

Total Enclosed: \$ _____

Send check or money order to:
NASA Tech Briefs, Fulfillment Dept.
41 East 42nd Street, New York, NY 10017

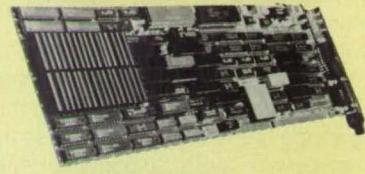
America's best inventions...
its premier researchers...
its top technology managers...
all in one place, at one time.

Technology 2002

the third national technology transfer conference and exposition
December 1-3, 1992
Baltimore, MD Convention Center

Sponsored by NASA, NASA Tech Briefs, and the Technology Utilization Foundation, with the participation of leading federal agencies and their contractors.

Circle Reader Action No. 561



4 MEG VIDEO Model 10

Flexible Image Processor and Application Accelerator For The PC/AT

- 8 to 8000 Pixels per Line
- 2 to 19 MHz sampling/display rate
- 10 MIPS Programmable Accelerator
- 4 Megabytes of Reconfigurable Image Memory
- RS-170, RS-330, and CCIR input/output
- Variable timing for nonstandard formats
- Genlock to external timing sources
- Analog or digital inputs
- Software programmable timing/resolution

 **EPIX**

3005 MacArthur Blvd., Northbrook, IL 60062
708-498-4002 FAX: 708-498-4321

Circle Reader Action No. 443

Subject Index

A

ACOUSTIC LEVITATION
Acoustic measurement of periodic motion of levitated object
page 58 NPO-18191

ACOUSTIC MEASUREMENT
Acoustic device would measure density of gas
page 34 NPO-18155

ADHESIVES
Thread-pull test of curing adhesive
page 71 MSC-21782

AERODYNAMIC STABILITY
Bifurcations in unsteady flows
page 63 ARC-12232

AERODYNAMIC STALLING
Stall-departure-resistance enhancer
page 61 LAR-14221

AERODYNAMICS
An implementation of the solution-adaptive-grid method
page 64 ARC-12736

AEROTHERMO-CHEMISTRY
Eleven-species thermochemical model of air
page 52 LAR-14447

AEROTHERMO-DYNAMICS
Supercomputers of the future
page 78 ARC-12416

AIR FLOW
Bifurcations in unsteady flows
page 63 ARC-12232

AIRFOILS
Finding the laminar-to-turbulent transition
page 64 ARC-12390

ALUMINUM ALLOYS
Gas contamination in plasma-arc-welded aluminum
page 73 MFS-27233

B

BALL BEARINGS
Lubricant for use in liquid oxygen
page 61 MFS-29760

BALLOONS
Rapidly deployable enclosure
page 58 MFS-28512

BEARINGS
Gauge measures large spherical bearing surfaces
page 62 KSC-11485

BIOINSTRUMENTATION
Thin-membrane sensor with biochemical switch
page 79 MFS-26121

BOOTS (FOOTWEAR)
Moving and working on space structures
page 73 MSC-21556

BORDERS
Computer aids delineation of boundaries in farmlands
page 74 ARC-12805

BOUNDRARIES
Computer aids delineation of boundaries in farmlands
page 74 ARC-12805

BOUNDARY LAYER TRANSITION

Finding the laminar-to-turbulent transition
page 64 ARC-12390

BOUNDARY SEPARATION

Stall-departure-resistance enhancer
page 61 LAR-14221

CARBON-CARBON COMPOSITES

Determining the degree of graphitization in carbon composites
page 46 NPO-18073

CARGO

Lifting loads with two helicopters
page 67 ARC-11812

CERAMICS

Ceramic-fibrous-insulation thermal-protection system
page 46 ARC-11888

CESIUM

Environmental tests of cesium frequency standards
page 25 NPO-18273

CHARGE COUPLED DEVICES

Open-pinned-phase charge-coupled device
page 16 NPO-17855

CHARTS

Software for generating graphs and charts
page 57 LAR-14505

CLIPS

Moving and working on space structures
page 73 MSC-21556

COMBUSTION CHAMBERS

Orifices for fuel-film cooling of combustion chamber
page 44 NPO-18225

COMMERCIAL AIRCRAFT

Oblique-flying-wing super-sonic transport airplane
page 66 ARC-12525

COMPILERS

Fault-tree compiler program
page 57 LAR-14586

COMPOSITE MATERIALS

Determining the degree of graphitization in carbon composites
page 46 NPO-18073

COMPUTER GRAPHICS

Plotting program for aerodynamical computations
page 55 ARC-12751

DOORS

Software for generating graphs and charts
page 57 LAR-14505

DOOR

VOUS software facilitates development of other software
page 74 ARC-12571

COMPUTER PROGRAMMING

An implementation of the solution-adaptive-grid method
page 64 ARC-12736

COMPUTERIZED SIMULATION

Automatic generation of countdown-simulating software
page 56 MFS-26091

COOLERS

Simulating welding-robot trajectories for previewing
page 72 MFS-29747

COORDINATES

Vortex-blob simulation of two-dimensional flows
page 54 ARC-12810

CONTROL

Stepping-motion motor-control subsystem for testing bearings
page 24 GSC-13418

COOLERS

Joule-Thomson cooler produces nearly constant temperature
page 42 NPO-18184

COORDINATES

Two-dimensional vernier scale
page 59 MSC-21700

COUNTDOWN

Automatic generation of countdown-simulating software
page 56 MFS-26091

CRYOGENICS

Ribbon cable strap partly free of backlash
page 60 GSC-13371

CURING

Thread-pull test of curing adhesive
page 71 MSC-21782

DAMPING

More about nonobstructive particle damping
page 63 MFS-29752

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

More about nonobstructive particle damping
page 63 MFS-29752

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

More about nonobstructive particle damping
page 63 MFS-29752

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

D

DAMPING

Truly: Spinoffs Will Spur Economy (continued from page 11)

Mars has been quiescent for millions of years. There is every possibility that as we explore its deep canyons, climb its towering mountains, and traverse its plains, we will make an exponential leap in understanding the origin and evolution of the solar system, of our planet, and perhaps even life itself.

To achieve these goals, NASA has embarked on a new cycle of technology development. We are, or will be, working in such areas as artificial intelligence, virtual reality, advanced robotics, artificial self-sustaining ecological systems, telepresence and teleoperation, process automation, new materials, highly advanced computers, and hypersonic flight.

Last year, Dr. Allan Bromley (presidential science advisor and Technology 2000 keynote speaker) said the real importance of a conference and exposition such as this is to allow people to see for themselves and to ask questions. That leads to insights, which, in turn, lead to creative ideas.

You hold the potential to convert these ideas into reality. American industry must take the lead in capturing the immense opportunities resident in our space program. □

HAULING
Lifting loads with two
helicopters
page 67 ARC-11812

HEAT PIPES
Computer program for
variable-conductance
heat pipes
page 54 LEW-14933

HELICOPTERS
Lifting loads with two
helicopters
page 67 ARC-11812

**HIGH TEMPERATURE
SUPERCONDUCTORS**
Measuring thermal diffusivity of a high-T_c
superconductor
page 34 GSC-13392

NONCONTACT MEASUREMENT
of critical current in
superconductor
page 32 NPO-18255

HOLE BURNING
Tomographic measurement of laser-bored holes
page 68 MFS-29770

HOT WORKING
Improved warm-working
process for an iron-base
alloy
page 69 MFS-28503

IMAGE ANALYSIS
Analyzing satellite images
of the ocean
page 52 GSC-13320

IMAGE PROCESSING
Computer aids delineation
of boundaries in
farmlands
page 74 ARC-12805

**IMAGING
TECHNIQUES**
Gel-filled holders for
ultrasonic transducers
page 38 LAR-14027

INFERENCE
Evaluation of threshold
functions for searches
among data
page 77 NPO-18113

**INFLATABLE
STRUCTURES**
Rapidly deployable
enclosure
page 58 MFS-28512

**INFORMATION
THEORY**
Evaluation of threshold
functions for searches
among data
page 77 NPO-18113

INJECTORS
Orifices for fuel-film cooling
of combustion
chamber
page 44 NPO-18225

INSULATION
Ceramic-fibrous-insulation
thermal-protection system
page 48 ARC-11888

IRON ALLOYS
Improved warm-working
process for an iron-base
alloy
page 69 MFS-28503

LUBRICANTS
Lubricant for use in liquid
oxygen
page 61 MFS-29760

**LINEAR
PROGRAMMING**
Menu-driven solver of
linear-programming
problems
page 57 LEW-14978

LIQUID OXYGEN
Lubricant for use in liquid
oxygen
page 61 MFS-29760

LEVITATION
Acoustic measurement of
periodic motion of
levitated object
page 58 NPO-18191

**LINEAR
PROGRAMMING**
Menu-driven solver of
linear-programming
problems
page 57 LEW-14978

LIQUID OXYGEN
Lubricant for use in liquid
oxygen
page 61 MFS-29760

LUBRICANTS
Lubricant for use in liquid
oxygen
page 61 MFS-29760

M

JOINTS (JUNCTIONS)
Computing large-angle
transients in structures
page 54 LAR-14382

**HIGH-PRESSURE LEAD-
THROUGH JOINT**
High-pressure lead-through
joint
page 69 MFS-28404

**JOULE-THOMSON
EFFECT**
Joule-Thomson cooler
produces nearly constant
temperature
page 42 NPO-18184

**IMAGING
TECHNIQUES**
Gel-filled holders for
ultrasonic transducers
page 38 LAR-14027

**JOULE-THOMSON
EFFECT**
Joule-Thomson cooler
produces nearly constant
temperature
page 42 NPO-18184

**MATHEMATICAL
PROGRAMMING**
Menu-driven solver of
linear-programming
problems
page 57 LEW-14978

**MEASURING
INSTRUMENTS**
Acoustic device would
measure density of gas
page 34 NPO-18155

**Gauge measures large
spherical bearing
surfaces**
page 62 KSC-11485

**Two-dimensional vernier
scale**
page 59 MSC-21700

PAGE 59 MSC-21700

**MEASURING
INSTRUMENTS**
Tissue-simulating gel for
medical research
page 80 LAR-14036

MEMBRANES
Thin-membrane sensor
with biochemical switch
page 79 MFS-26121

METAL POWDER
Platable filler and sealant
page 70 MFS-29735

METAL WORKING
Improved warm-working
process for an iron-base
alloy
page 69 MFS-28503

MODULATION
Resolution of phase ambiguities in QPSK
page 28 NPO-18083

MONITORS
Monitoring subsystem for
testing bearings
page 24 GSC-13432

MOTORS
Monitoring subsystem for
testing bearings
page 24 GSC-13432

**RADIATION
MEASURING
INSTRUMENTS**
Simple Schlieren light
meter
page 23 LAR-14249

RADI
Gauge measures large
spherical bearing
surfaces
page 62 KSC-11485

REFRIGERATORS
Joule-Thomson cooler
produces nearly constant
temperature
page 42 NPO-18184

RELIABILITY ANALYSIS
Fault-tree compiler
program
page 57 LAR-14586

**RELIABILITY
ENGINEERING**
Detecting latent faults in
digital flight controls
page 25 ARC-12333

NEURAL NETS
Evaluation of threshold
functions for searches
among data
page 77 NPO-18113

REMOTE SENSING
Assessment of ac-
curacies of remote-
sensing maps
page 78 ARC-12371

L

LANDSAT SATELLITES
Assessment of ac-
curacies of remote-
sensing maps
page 78 ARC-12371

LASER APPLICATIONS
Tomographic measure-
ment of laser-bored holes
page 68 MFS-29770

LEVITATION
Acoustic measurement of
periodic motion of
levitated object
page 58 NPO-18191

**LINEAR
PROGRAMMING**
Menu-driven solver of
linear-programming
problems
page 57 LEW-14978

LIQUID OXYGEN
Lubricant for use in liquid
oxygen
page 61 MFS-29760

LUBRICANTS
Lubricant for use in liquid
oxygen
page 61 MFS-29760

LUBRICANTS
Lubricant for use in liquid
oxygen
page 61 MFS-29760

O

OCEANOGRAPHY
Analyzing satellite images
of the ocean
page 52 GSC-13320

ORBITAL LIFETIME
LOP—long-term orbit
predictor
page 56 NPO-17052

ORIFICES
Orifices for fuel-film cool-
ing of combustion
chamber
page 44 NPO-18225

OSCILLATIONS
Acoustic measurement of
periodic motion of
levitated object
page 58 NPO-18191

OXIDIZERS
Rhenium-foil witness
cylinders
page 44 NPO-18224

P

PHASE SHIFT KEYING
Resolution of phase am-
biguities in QPSK
page 28 NPO-18083

PHOTOVOLTAIC CELLS
Flexible, thin-film solar-
cell blanket
page 20 NPO-18196

**PLASMA ARC
WELDING**
Gas contamination in
plasma-arc-welded
aluminum
page 73 MFS-27233

PLOTTING
Plotting program for
aerodynamical
computations
page 55 ARC-12751

**PREFLIGHT
OPERATIONS**
Automatic generation of
countdown-simulating
software
page 56 MFS-26091

PRESSURE VESSELS
High-pressure lead-
through joint
page 69 MFS-28404

**PROTECTIVE
COATINGS**
Ceramic-fibrous-insulation
thermal-protection system
page 48 ARC-11888

PROTECTORS
Rapidly deployable
enclosure
page 58 MFS-28512

PUMPS
Rotodynamic behavior of
sawtooth-pattern damping
seals
page 63 MFS-27242

R

**RADIATION
MEASURING
INSTRUMENTS**
Simple Schlieren light
meter
page 23 LAR-14249

RADI
Gauge measures large
spherical bearing
surfaces
page 62 KSC-11485

REFRIGERATORS
Joule-Thomson cooler
produces nearly constant
temperature
page 42 NPO-18184

RELIABILITY ANALYSIS
Fault-tree compiler
program
page 57 LAR-14586

**RELIABILITY
ENGINEERING**
Detecting latent faults in
digital flight controls
page 25 ARC-12333

REMOTE SENSING
Assessment of ac-
curacies of remote-
sensing maps
page 78 ARC-12371

Where Buyers Have it Made!

February 19, 20 & 21, 1992

Long Beach Convention Center, Long Beach, California

SERVING: Air Transport, Space, Military, Ground Support,
Civil Aviation, Interior/Exterior Furnishings & Supplies,
Overhaul & Maintenance and Avionics.

EXHIBITORS

Aerospace-qualified job shops and contract manufacturers with expert capabilities in Avionics, Metal Working, Plastics, Composites, Rubber and suppliers of Components, Parts, Test Equipment and Materials.

FOR INFORMATION TO EXHIBIT OR ATTEND
FAX 1-313-643-0856 or CALL 1-800-635-9885.

*Complimentary tickets available for qualified attendees.

CME/AEROCON 92 exhibit attend

NAME _____

COMPANY _____

ADDRESS _____

CITY, STATE, ZIP _____

PHONE & FAX _____



ADVERTISERS INDEX

3-D Visions	(RAC 669)*	9
3M Electrical Specialties Division	(RAC 606,409)	94,95
Aerospace Optics, Inc.	(RAC 309)	13
Algor Interactive Systems, Inc.	(RAC 361)	36
Allied Signal, Inc.	(RAC 415)	44-45
Amoco Performance Products, Inc.	(RAC 336,486)	17,47
AMP	(RAC 657,517)	18-19,30-31
Apex Microtechnology Corporation	(RAC 685)	28
Astro-Med, Inc.	(RAC 588)	5
Autodesk Retail Products	(RAC 420)	1
AZ-USA, Inc.	(RAC 478)	60
Bancomm	(RAC 658)	102
CME/AEROCON 92	(RAC 636)	114
Cole-Parmer Instrument Company	(RAC 533-536,638)	49-51,108
CONTEC Microelectronics USA, Inc.	(RAC 440,688)	104,112
Contemporary Cybernetics Group	(RAC 411)	COV II
Cyber Research, Inc.	(RAC 371)	26-27
Dataq Instruments, Inc.	(RAC 489)	112
Datum, Inc.	(RAC 454)	72
Document Engineering	(RAC 312)	111
Dolphin Scientific, Inc.	(RAC 510)	84
DYNAIR Electronics, Inc.	(RAC 350)	55
Edmund Scientific Co.	(RAC 461)	41
Electro Scientific Industries, Inc.	(RAC 625)	60
Eigiloy Limited Partnership	(RAC 373)	85
Elmo Manufacturing Corp.	(RAC 509)	96
EPIX, Inc.	(RAC 443)	113
Fluoramics, Inc.	(RAC 364)	82
Folsom Research	(RAC 648,513)	22,86
Frequency Electronics, Inc.	(RAC 640)	COV III
F.W. Bell	(RAC 316)	75
Galaxy Applied Engineering, Inc.	(RAC 406)	98
Glassman High Voltage, Inc.	(RAC 358)	2
Gould Test & Measurement	(RAC 483,484)	33,53
Hardig Cases	(RAC 492)	25
Hemco Corporation	(RAC 616)	106
Holometric, Inc.	(RAC 481)	112
Houston Instrument	(RAC 550)	35
IBM Corporation		21
Ilbruck, Inc.	(RAC 466)	91
Inframetrics	(RAC 370)	15
International Light, Inc.	(RAC 645)	81
Instrumentation Marketing Corp.	(RAC 556)	70
Integrated Systems, Inc.	(RAC 567)	84
Jandel Scientific	(RAC 580)	12
Kaman Instrumentation Corporation	(RAC 472)	104
Kevex X-Ray	(RAC 531)	83
Laboratories Technologies Corp.	(RAC 423)	101
Magnetic Instrumentation, Inc.	(RAC 348)	73
Master Bond, Inc.	(RAC 619,604)	38,111
MathSoft, Inc.	(RAC 682)	39
Microstar Laboratories	(RAC 552)	98
Mikron Instrument Co., Inc.	(RAC 390,592)	91,115
Minco Products, Inc.	(RAC 308)	93
Modgraph Inc.	(RAC 435)	65
Molytek, Inc.	(RAC 632)	87
National Design Engineering Show & Conference	(RAC 340)	76
National Instruments	(RAC 681,691,581)	3,37,105
National Technical Systems	(RAC 404)	80
NEOS Technologies, Inc.	(RAC 577)	112
Niclet Instruments	(RAC 697)	COV IV
Numerical Algorithms Group, Inc.	(RAC 477)	71
Patton & Patton		
Software Corporation	(RAC 499)	77
Precision Filters, Inc.	(RAC 306)	4
PULNIX America, Inc.	(RAC 416)	88
Quantitative Technology Corp.	(RAC 633)	85
Rdf Corporation	(RAC 670)	20
RGB Spectrum	(RAC 467,468)	8,23
Rolyn Optics Co.	(RAC 551)	112
Scientific Programming Enterprises	(RAC 408)	73
Stanford Research Systems	(RAC 445,512)	7,43
Structural Research & Analysis Corporation	(RAC 676)	59
Syntex Rubber Corporation	(RAC 515)	116
Systech Corporation	(RAC 511)	112
Technology 2001 Proceedings	(RAC 561)	93
Technology 2002	(RAC 561)	113
The Recorder Company	(RAC 519)	112
The Uniform Association	(RAC 595)	112
Tiodize Company, Inc.	(RAC 422)	62
TransEra Corporation	(RAC 473,382)	40,107
Walker Scientific, Inc.	(RAC 599)	112
Wavetek Corporation	(RAC 448,449)	29
XYZTEK Corporation	(RAC 377)	87
Zero Plastics	(RAC 614)	65
Zircar Products, Inc.	(RAC 323)	106

*RAC stands for Reader Action Card. For further information on these advertisers, please circle the RAC number on the Reader Action Card in this issue. This index has been compiled as a service to our readers and advertisers. Every precaution is taken to insure its accuracy, but the publisher assumes no liability for errors or omissions.

RHENIUM

Rhenium-foil witness cylinders
page 44 NPO-18224

RIBBONS

Ribbon cable strap party free of backlash
page 60 GSC-13371

ROBOTICS

Simulating welding-robot trajectories for previewing
page 72 MFS-29747

ROLLERS

Two-axis track rollers
page 66 MFS-28470

S

SATELLITE IMAGERY

Analyzing satellite images of the ocean
page 52 GSC-13320

SATELLITE ORBITS

LOP—long-term orbit predictor
page 56 NPO-17052

SATELLITE TEMPERATURE

Computer program for variable-conductance heat pipes
page 54 LEW-14933

SCHLIEREN PHOTOGRAPHY

Simple Schlieren light meter
page 23 LAR-14249

SEALERS

Platable filler and sealant page 70 MFS-29735

SEALS (STOPPERS)

High-pressure lead-through joint
page 69 MFS-28404

Rotordynamic behavior of sawtooth-pattern damping seals
page 63 MFS-27242

SEMICONDUCTOR DEVICES

Open-pinned-phase charge-coupled device
page 16 NPO-17855

SEMICONDUCTOR LASERS

Double-current-confined CSP laser
page 22 LAR-14200

SIGNAL DETECTION

Resolution of phase ambiguities in QPSK
page 28 NPO-18083

SOFTWARE ENGINEERING

VOUS software facilitates development of other software
page 74 ARC-12571

SOLAR BLANKETS

Flexible, thin-film solar-cell blanket
page 20 NPO-18196

SOLID STATE DEVICES

Open-pinned-phase charge-coupled device
page 16 NPO-17855

SPACE COMMUNICATION

Double-current-confined CSP laser
page 22 LAR-14200

SPACESHIFT ORBITS

LOP—long-term orbit predictor
page 56 NPO-17052

SPACESHIFT STRUCTURES

Moving and working on space structures
page 73 MSC-21556

SPECLE HOLOGRAPHY

Digital correlation in laser-speckle velocimetry
page 40 MFS-26122

STRAPS

Ribbon cable strap party free of backlash
page 60 GSC-13371

STRUCTURAL VIBRATION

More about nonobstructive particle damping
page 63 MFS-29752

SUPERCONDUCTORS

Measuring thermal diffusivity of a high-T_c superconductor
page 34 GSC-13392

Noncontact measurement of critical current in superconductor
page 32 NPO-18255

SUPERCOMPUTERS

Supercomputers of the future
page 78 ARC-12416

SUPersonic FLOW

Program solves Euler equations of supersonic flow
page 56 LAR-14228

SUPERSONIC TRANSPORTS

Oblique-flying-wing supersonic transport airplane
page 66 ARC-12525

SWITCHES

Thin-membrane sensor with biochemical switch
page 79 MFS-26121

T

TAILLESS AIRCRAFT

Oblique-flying-wing supersonic transport airplane
page 66 ARC-12525

TEST EQUIPMENT

Stepping-motion motor-control subsystem for testing bearings
page 24 GSC-13418

TURBULENCE

Supercomputers of the future
page 78 ARC-12416

V

WELDING

Simulating welding-robot trajectories for previewing
page 72 MFS-29747

Portable Blackbody Calibration Source features high emissivity & remarkable accuracy of 0.05%!

NIST Traceable



Mikron's M360 blackbody radiation calibration source features a spherical cavity with a 25mm (1.0") dia. aperture, operates over the 50 to 1100°C range with an emissivity of +0.999 ±0.005 and resolution of 0.1°. Source and controller are housed in separate modules, permitting remote location of the source.

The M360 is one of 8 different precision Mikron units for calibration of infrared thermometers, radiometers, FLIR, heat flux meters, etc. covering a span from sub-zero to 3000°C.

 MIKRON®

445 W. Main St., Wyckoff, NJ 07481 U.S.A.
TEL: 201-891-7330 • FAX: 201-891-1205

Send for information today!

Circle Reader Action No. 592

From one to a billion.

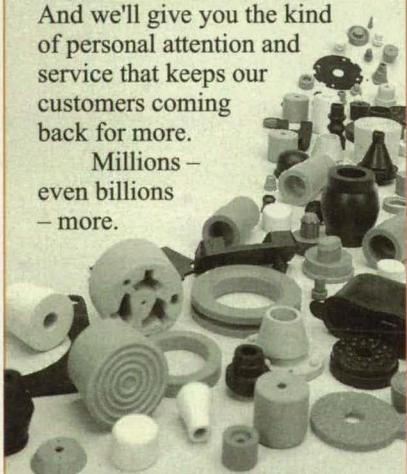
If we can give you 3-day delivery on one prototype rubber part — how long will it take for a billion parts?

Try us and see. You'll be surprised. Our modern manufacturing facilities ensure on-time delivery — on orders from 100 to 1 billion units at very competitive prices. And our SPC Program assures you of consistently high quality on orders of any size.

As for our 3-day prototypes, just send us a sketch, blueprint or product sample — and we'll take it from there. We'll analyze your design, select the compound, and produce sample parts that meet your exact needs.

So, whatever your requirements, give us a try. And we'll give you the kind of personal attention and service that keeps our customers coming back for more.

Millions — even billions — more.



SYNTEX
RUBBER CORPORATION

938 Crescent Avenue, P.O. Box 4006 8G01
Bridgeport, CT 06607
Tel (203) 367-8469 Fax (203) 367-6403

Mission Accomplished



Photo courtesy of Electronic Imagery Inc.

Image processing software developed for the space shuttle offers a host of terrestrial uses.

Like travelers who return home to find their best photos marred by overexposure, shuttle crews analyzing films of their missions have often wished for a chance to reshoot pictures captured with the craft's electronic camera system. New image processing software from Electronic Imagery, Delray Beach, FL, provides that opportunity by allowing mission photos to be viewed while in orbit. The software produces high-resolution images that can be enhanced and downlinked to ground-based scientists, who can relay evaluations and recommendations in near-real-time.

A grant from NASA's Small Business Innovation Research (SBIR) program, along with input from researchers at the Johnson Space Center, helped Electronic Imagery develop ImageScale PLUS. "NASA chose our package for its openness and flexibility," said Cindy Seiffert, the company's president.

ImageScale PLUS flew on Discovery in September 1991, becoming the first image processing software used aboard a shuttle. "The software enabled the astronauts to correct problems in their photographic techniques before it was too late," said Doug Holland, an engineer with the NASA electronic still camera project. According to Holland, every shuttle crew on the current flight manifest has requested the software be on board. It will help document crew activity, satellite deployment, troubleshooting, and microscopic biological experiments.

ImageScale PLUS allows the user to display the high-resolution images on a small monitor—a necessity in the shuttle's confined quarters—and then, employing a variable-size crop-

box, to select a portion for closer examination. As the user telescopes in on an image's details, the program provides with each successive subsampling the maximum resolution possible with the monitor.

In addition to generating photographs of Earth from space, useful in assessing natural disasters and other phenomena, the software is being applied in agriculture, atmospheric science, petroleum core sampling, neurology, particle analysis, and textile design. Features important in the processing of satellite images, such as lossless compression, are likewise critical in fields such as radiology and ophthalmology.

"The software is designed to be the engine behind any application employing digital images," said Jean Molnar, Electronic Imagery's director of communications. The laptop-compatible package can process digital data from CCD cameras, live video, scanners, microscopes, and ultrasound or MRI devices. The images can be any size or pixel depth, at resolutions up to 4096 x 4096. A user-friendly interface allows even novices to successfully process images, while more experienced users can implement macros or create custom menus. Other features include a full complement of drawing and text utilities, histogram sliding and stretching, full-color transformations, and unique zoom and pan capabilities.

As ImageScale PLUS accompanies shuttle crews on upcoming flights, company researchers will continue to enhance the software's capabilities for both space and Earth applications. Plans include porting to UNIX and Windows and further development of compression techniques. □

Space Proven

**FEI SPACE QUALIFIED DC-DC CONVERTERS
DELIVER HI-REL PERFORMANCE ON TIME AND ON BUDGET!**



Frequency Electronics ... specialists in high-performance, space proven products ... having supplied more than 3,000 units in over 90 satellite programs, continues in that 27-year tradition with Hi-Rel, Rad-Hard DC to DC converters.

These units can meet your most demanding specifications by tailoring our standard modular designs.

If you want out of this world performance, with down to earth delivery and pricing, call Frequency Electronics today.

DC-DC CONVERTER FEATURES:

- Radiation hardened
- Inputs to 100 V DC
- Outputs to 200 W
- Regulation to 0.1%
- Power density to 0.16 W/gm (5W/oz)
- Efficiency to 85%
- Multiple outputs



FREQUENCY ELECTRONICS, INC.

55 Charles Lindbergh Blvd., Mitchel Field, NY 11553
516-794-4500 • FAX: 516-794-4340

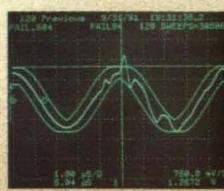
Circle Reader Action No. 640

PRINCIPLES OF QUALITY MEASUREMENT: THIRD IN A SERIES.

TOTAL QUALITY MEASUREMENT

When talk about quality turns into action, you're the one out in front. Because quality improvement depends on quality measurements. And quality measurements depend on you.

You know you'll never reach perfection if you can't measure the error. And as you push the error down, your standards for accuracy can only rise.



One-percent tolerance is a thing of the past - this year's noise level may be next year's upper limit.

At Nicolet, our standards are as high as yours. We make oscilloscopes and transient analyzers that deliver measurements, not just pictures. Instruments that respect your data, and maintain your reputation. We'll support your drive for perfection - every small step of the way.

Nicolet has the features more measurement experts prefer.

A national survey of measurement specialists rated these Nicolet features "most important" when selecting a new digital oscilloscope or waveform recorder:

Flexible triggering - Full analog arm and trigger on every advanced trigger mode.

Highest resolution - Your choice of 8 or 12-bit models, with the industry's lowest static error.

Deep memories - Standard 256K words per channel on PRO oscilloscopes; up to 3 megawords per channel on MultiPro transient analyzers.

Full programmability - Automation of your test or analysis without an external PC.

Fast averaging - Real-time averaging up to 100 per second.

Envelope tests - Fully automatic limit testing for unattended monitoring.

Math functions - Quick data processing from the front panel, optional keyboard, or under program control.

Differential inputs - Full accuracy, without contamination by unstable grounds and EMI.

At Nicolet, we build instruments for measurement experts like you.

Nicolet

INSTRUMENTS OF DISCOVERY

Nicolet Measurement Instruments

Madison, Wisconsin, USA 53711-4495

608/271-3333, FAX 608/273-5061

In Canada Call: 800/387-3385

Circle Reader Action No. 697